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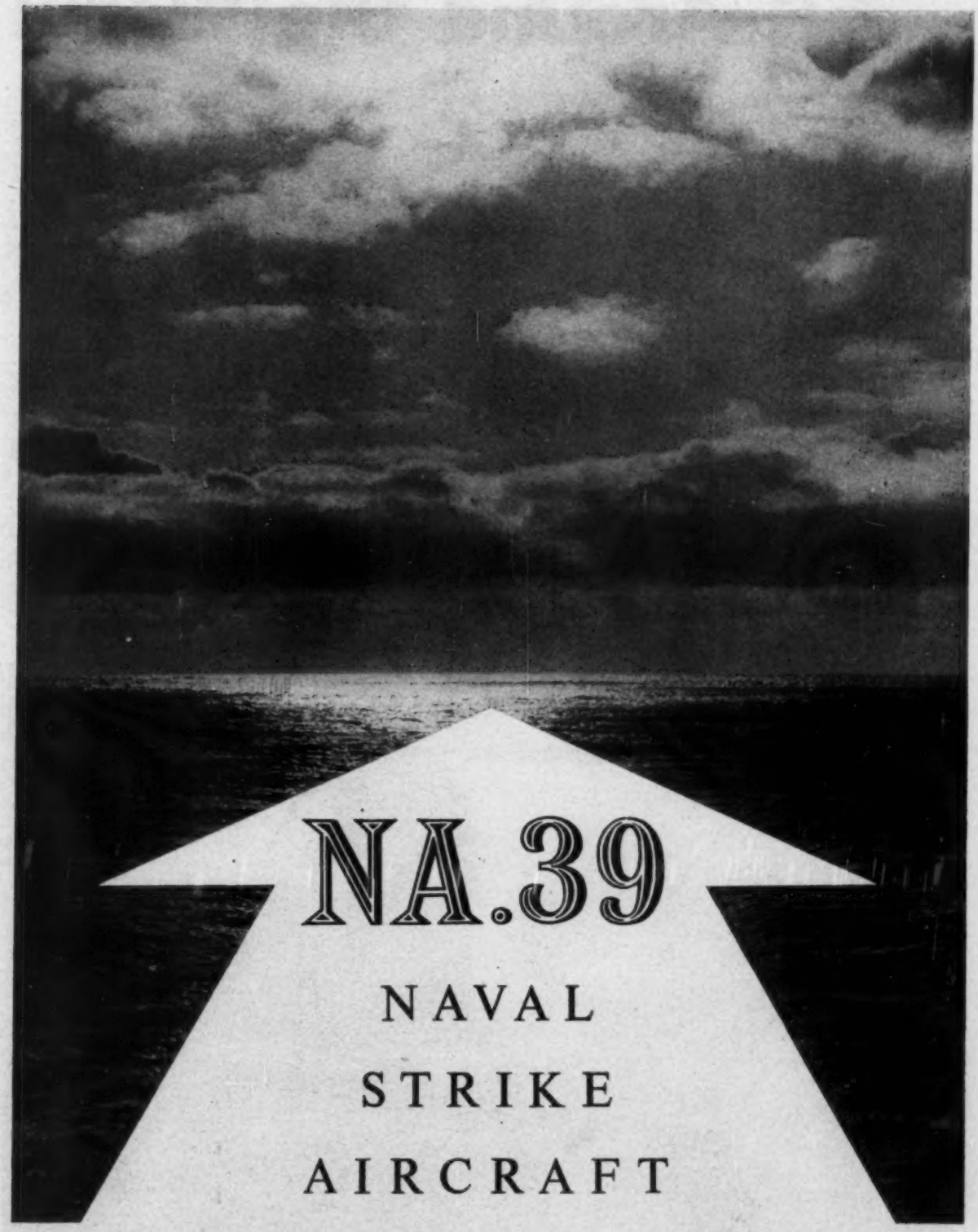

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A

Around the World

S-58s TO WEST GERMANY – Twenty-six Sikorsky S-58 helicopters have been ordered by the West German Ministry of Defense. Five of the S-58s, some with flotation gear and rescue hoists, will be assigned to the German Air Force. Others will serve with Army units. These helicopters are similar to those flown by three commercial airlines, Sabena, New York Airways, and Chicago Helicopter Airways, and by a number of military services.

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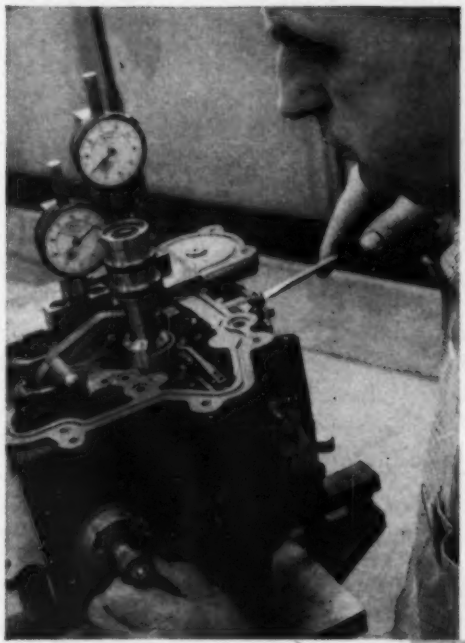

CONTROLLING JET FUEL—Hamilton Standard gas turbine fuel controls are being produced for all Boeing 707 and Douglas DC-8 jet transports with Pratt & Whitney Aircraft power plants. One is shown here in final assembly. Hamilton Standard is supplying fuel controls for 12 aircraft types, including the *Snark* missile. In addition, Hamilton Standard currently manufactures starters, air conditioning systems, valves, pumps and propellers. Its products are used on more than 50 types of modern, turbine-powered aircraft.

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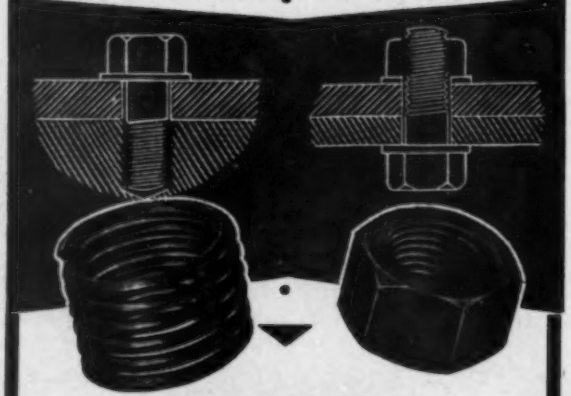

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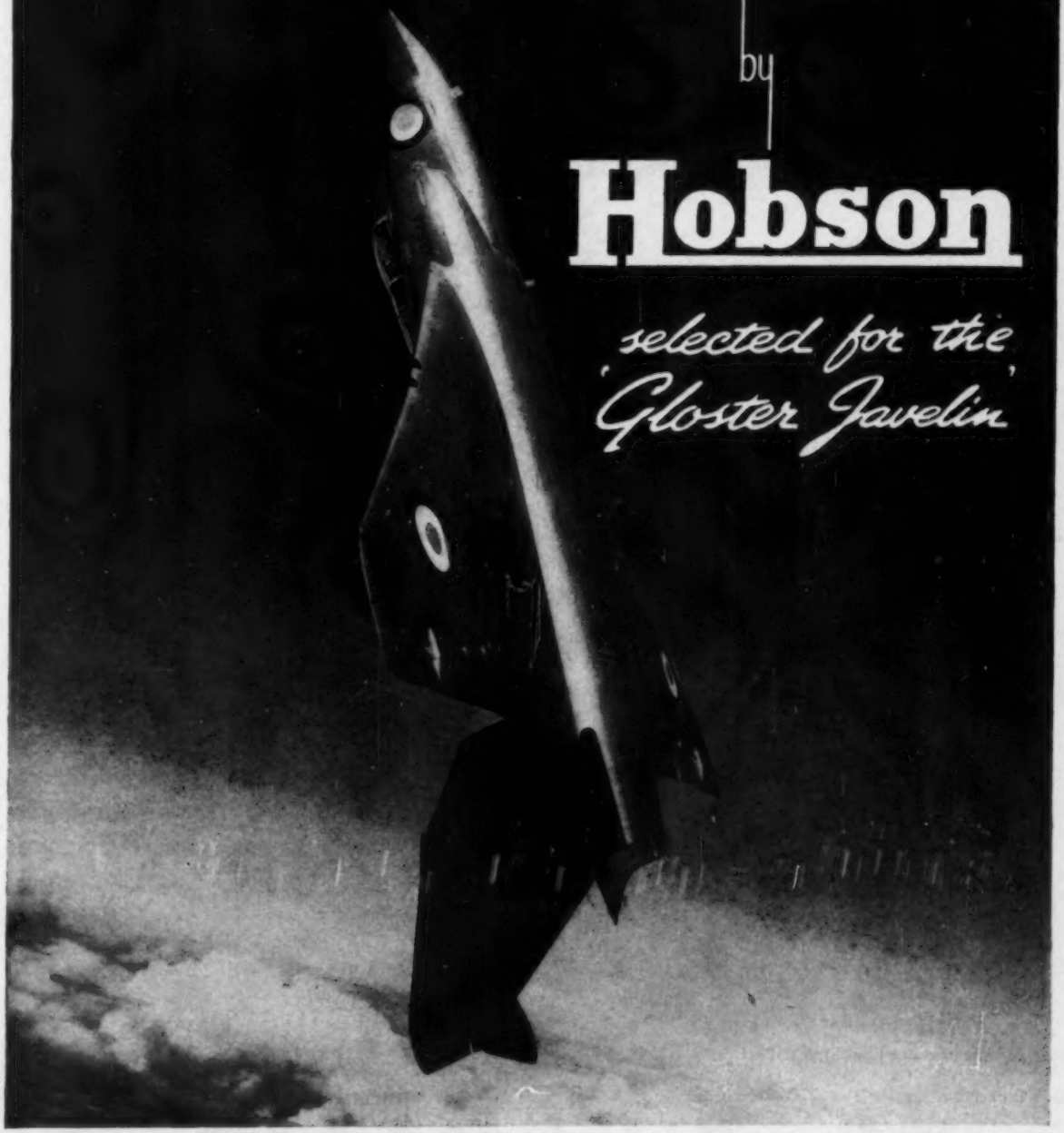

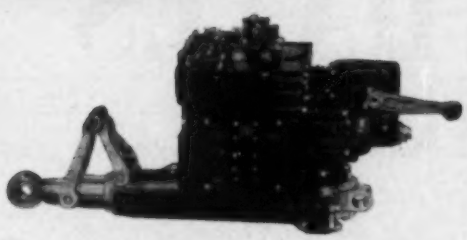

Many of Britain's leading aircraft designers are now specifying Hobson Power Flying Controls for operation of the primary control surfaces, including "All-Flying" or "Slab" tailplanes. The duplicated hydraulically operated single screw jack unit, as illustrated, is typical of Hobson units fitted to the Gloster Javelin.

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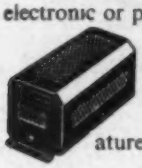
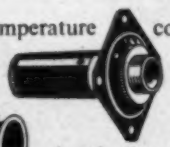


humidity controllers



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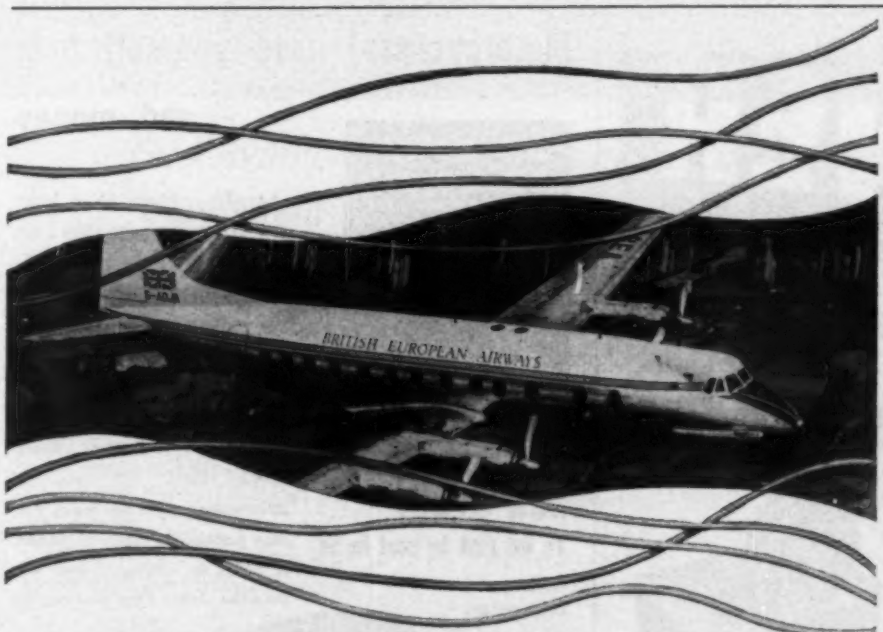

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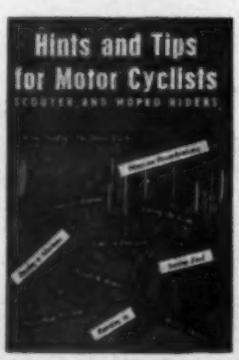

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AIRCRAFT ENGINEER

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In this issue

502 Vulcans in Service
508 Two New Simulators
511 London's New Air Terminal
512 Victor B.1
514 Air Radio Developments
517 Leader of "The Few"
519 The Folkestone Conference
526 Croydon Under Sentence

An Experiment with Time

WE have often reflected that modern aeroplanes of the larger and more complicated sort take an unconscionable time a-flying — and still longer to become usable implements or weapons. The thought recurs on reading in this issue that the elapsed time between the Avro Vulcan specification being received at Manchester and the placing of the type in R.A.F. squadron service was nine years and eight months.

Did any weapon in any era demand so lengthy a period of forging, tempering and proving as does, apparently, a modern bomber? Yet Britain as a nation, and Avro as a company, have small cause for apology, for the corresponding period in the history of the B-52 was only four months shorter—and this with all the immensity of Boeing's technical resources and their incomparable experience of B-47 production.

To us in Britain such considerations are now academic—for the simple reason that the R.A.F. are to have no big bombers at all after the later Vulcans and Victors. What does concern us, and very directly indeed, is the possibility of speeding up the production and development times of our future transports. In this regard we shall do well to note that Lockheed, spurred by the prospect of lucrative civil and military business (and helped by the availability of the Bristol Orpheus lightweight turbojet) have produced their JetStar prototype—a baby Caravelle—in 241 days.

It may be recalled that the first announcement of this aeroplane came at the beginning of the year, when it was declared that a prototype would fly on September 4. Lockheed's redoubtable "Kelly" Johnson had, in fact, scheduled the maiden flight for 9 a.m. on that day; and when the day came his prediction was more than fulfilled, for by 9 a.m. the JetStar had been in the air for two whole minutes!

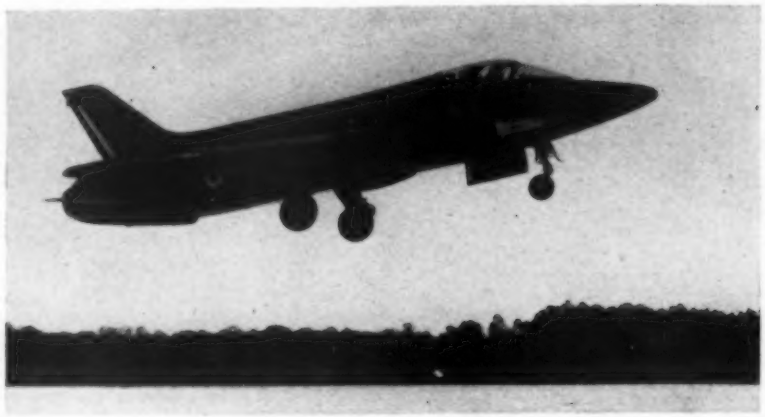
Admitting that P.R.O.-manship may have played a part in this achievement, it is an achievement none the less—and very much "An Experiment with Time," wherein we in this country may read a lesson.

STOL Challenge

OUR first abstract of Mr. A. E. Raymond's Plesman Memorial Lecture last week concluded with what amounted to a loud, clear challenge to the British aircraft industry. "Perhaps the most significant development [in civil aviation] could take place," said Douglas's V-P Engineering, "with the arrival of medium-sized transports in the STOL class, equipped for operating in the less developed areas of the world." Mr. Raymond's further contention that the provision of sturdy, cheap-to-operate aircraft of "significant carrying capacity" could lend fresh impetus to the opening up of immense areas of the earth's surface is one which has previously been voiced in this journal—though we often wonder if its real significance has penetrated and permeated the industry as it might have done. It was in the further development of the theme that Mr. Raymond's paper took on a tone of inspiration as well as challenge. "Civilized and scientific exploitation of such great areas," he said, "in a world of increasing population and relatively decreasing food supplies, could go a very long way towards anticipating any increase of economic tensions in a world already over-tense." It was in this realm of development, and in the carrying of resultant produce to continental markets, he believed, that aviation yet has its greatest part to play.

This, then, is the challenge to British constructors: to exploit and expand the market already being Pioneered with airframes from Prestwick and piston engines from Coventry. To combine our turboprop and high-lift experience in STOL aeroplanes of medium-to-large capacity. And, while so doing, to keep the wariest of eyes on American, Russian and French developments in the same immensely promising field.

FROM ALL QUARTERS



PESKY NUISANCE: "Horsefly" is the straight translation of the name "Taon," borne by this Bréguet entry for the NATO light strike-fighter contest (see this page and page 517). Note the newly grown underfin on this business-like Orpheus-powered single-seater.

First Avro Arrow

NEXT Friday, October 4, the first Arrow CF-105 to leave the assembly shops of Avro Aircraft, Ltd., Malton, Ont., is due to be "unveiled" by the Canadian Minister of National Defence, the Hon. George R. Pearkes, V.C., at a ceremony which will be attended by some 2,000 people, representative of the Government, the Services, industry and labour.

The CF-105, which is the first supersonic aircraft to have been designed and manufactured in Canada, will go to the flight test hangar at Malton after next Friday's ceremony for its extensive pre-flight test programme.

Canada-U.S. Visit by C.A.S.

ON Wednesday, Air Chief Marshal Sir Dermot Boyle, Chief of the Air Staff, was due to leave London Airport by Comet 2 of R.A.F. Transport Command—flying *via* Keflavik and Gander to Uplands, near Ottawa—for a visit to Canada and the U.S.A. as a guest of the R.C.A.F. and the U.S.A.F.

In Canada, he is to have discussions with the Canadian C.A.S., Air Marshal Hugh Campbell, and members of the R.C.A.F. Air Council. He will also visit Air Defence Command H.Q. at St. Hubert, Montreal, and the Avro Aircraft and Orenda factories.

On September 29 Sir Dermot is due to fly to Westover A.F.B., Mass, and at the invitation of Gen. Thomas D. White, Chief of Staff of the U.S.A.F., will spend a fortnight in the U.S.A., returning to this country by R.A.F. Comet on October 13.

Royal DC-7C

A DC-7C, chartered from B.O.A.C. by the Government, is to be used by the Queen and the Duke of Edinburgh on their journey to Canada and for their return from the U.S.A. next month. Commenting upon this decision to use an American aircraft, an M.T.C.A. announcement stated: "It had been hoped to use a long-range Britannia, but B.O.A.C. have only just taken delivery of their first aircraft of this type and there will not be time to complete the necessary programme of proving flights across the North Atlantic and the training of crews. Any other type of aircraft for these journeys would require one or possibly two refuelling stops *en route*, which owing to the weather conditions at that time of the year might involve appreciable delays."

Arrangements concerning details of the flight have not been completed, but it is intended that the DC-7C should fly from London to Uplands non-stop. The journey time will be about 13 hours and the aircraft should arrive at 4.30 p.m. on October 12.

S.A.C. Bombing Competition

DETAILS have just been published of U.S.A.F. participation in Operation Longshot, the Strategic Air Command bombing, navigation and reconnaissance competition next month in which two Vulcans and two Valiants of R.A.F. Bomber Command are taking part.

The S.A.C. is putting up 86 aircraft—66 B-47s, ten B-36s and ten B-52s. All the medium bombers concerned (including the R.A.F. team) will operate from Pinecastle A.F.B., Florida, and the twenty "heavies" from Carswell A.F.B., Fort Worth, Texas.

Pinecastle is the base for one of the B-47 wings taking part, the 321st, commanded by Col. Michael McCoy. An almost legendary figure in the U.S.A.F., Col. McCoy led the first mass flight of B-47s to Fairford in Gloucestershire during 1953; and during the war, when serving with the R.C.A.F., he survived a jump from a Spitfire at 2,000ft when his parachute failed to open and he landed in a deep snowdrift.

When the pilots of the competing B-47s from the 321st Wing take off they will clench a fist and cry "charge," following Col. McCoy's procedure which has been adopted by the wing—a combination of the clenched mailed fist (badge of the S.A.C.) and Teddy Roosevelt's famous charge.

Each wing of the S.A.C. can enter two aircraft, and there are thus 43 wings represented. As one U.S.A.F. officer put it, the competition is "as keen as the Olympics and as full of suspense, drama and sheer excitement as the World Series."

NATO Autumn Exercises

AIRCRAFT of R.A.F. Coastal Command, of the Fleet Air Arm, of the U.S.A.F. and U.S. Navy, of the R.C.A.F. and of French, Dutch and Norwegian Air Forces are participating with Naval forces in NATO exercises which began on September 18 in the North and Mid-Atlantic ("Strikeback," "Seawatch" and "Fendoff") and the Channel ("Standfirm"). These exercises last ten days and end tomorrow. They are under the overall control of Admiral Jerauld Wright, U.S.N., Supreme Allied Commander Atlantic. R.A.F. Shackletons, operating from bases in Cornwall, Northern Ireland, Scotland, Portugal and Gibraltar, in the first 72 hours carried out over 200,000 square miles of ocean search.

The NATO Contest

AT Brétigny, near Paris, on September 18, test pilots from Great Britain, the U.S.A., France and Italy (a picture appears on page 517) began their evaluation of five prototypes entered for the NATO lightweight strike-fighter contest. It is hoped that a decision will be reached by mid-November and that production models will be coming forward two years later. Brig-Gen. R. G. Brohon (French Air Force), one of the Allied advisers on the project, has said that "needs could be estimated at approximately 5,000 planes."

Asked if the Folland Gnat was among the ten aircraft for which tenders were originally put forward, Col. John J. Driscoll, U.S.A.F., said that it was, but that it had been found that it "did not quite meet SHAPE requirements." It had been built, he said, as an all-purpose aircraft, with emphasis on interception, and SHAPE believed that the day of the all-purpose aircraft was over. Col. Driscoll added that it was hoped that many NATO countries would participate in the construction of the type finally chosen.

Tactical trials will be the responsibility of a committee headed by German Air Force Colonel K. Kuhmley, described as "one of the Luftwaffe's leading tactical officers." Price of production aircraft is expected to be between £36,000 and £72,000.

Of the five prototypes entered, three have been built with NATO funds. These are the Fiat G-91, Bréguet 1001 Taon, and Marcel Dassault Etendard VI—all powered with the Bristol Orpheus lightweight turbojet. Entered as private ventures are the S.E.5003 Baroudeur (which takes off, lands and taxis on skids) and the Marcel Dassault Etendard IV. Both these machines have a SNECMA Atar.

Of the individual entries, the Fiat G-91 has already been ordered into pre-production to the extent of 27 aircraft. Concerning the Bréguet Taon, the following announcement has been issued: "With a view towards starting the production . . . under the best possible conditions, the Bréguet company has studied the production possibilities available in Europe and, subject to approval by the respective governments, has already reached industrial agreements. In Germany, the Bréguet company has come to an agreement with the Dornier company for the production of all or part of the Bréguet 1001. . . . The company is also prepared to enlist the co-operation of Great Britain and Italy to a large degree, and to this purpose has already begun preliminary discussions. With regard to the Benelux countries, the Bréguet company already has an industrial agreement with the Fokker company."

FAST WORKER: Designed as a general-utility transport/trainer to cruise at over 500 m.p.h., the Lockheed CL-329 JetStar ten-seater is seen in this first air-to-air view.

A somewhat similar statement, in the following terms, has been issued on behalf of Marcel Dassault: "The Light Tactical Fighter programme, since its conception, has always been an interallied project. It is also in this spirit of interallied co-operation that G.A.M.D. [Générale Aéronautique Marcel Dassault] has developed the integral European production for the Etendard VI and that the necessary agreements have been signed. In addition to Great Britain, represented by the Bristol Company, who will be supplying the jet engine chosen by interallied experts, Italy will take part in this production, since the Fiat company will participate in the series production of the Etendard VI. The newer German industry is already co-operating with G.A.M.D. in the realization of other aeronautical projects."

Starring the Vulcan

A FILM featuring the Avro Vulcan (the entry of which into R.A.F. squadron service forms the subject of an article on pp. 502-505 of this issue) is now nearing completion at R.A.F. Waddington.

Called *High Endeavour* and made by Martin Films, Ltd., it not only depicts Bomber Command crews on conversion courses and training for the bombing competition in the U.S.A. next month but also traces the long line of bomber aircraft made by A. V. Roe, Ltd., beginning with the Avro 504.

The film (in Eastman colour) runs for 45 minutes and it is classified "secret"; but Mr. John Martin, managing director of Martin Films, Ltd., hopes later to make a version for public showing with the classified portions omitted.

Civil Trials of Doppler Navigators

AT a public demonstration of their new civil PC-221A Doppler radar last week, General Precision Laboratories, Inc., announced that a Pan American DC-7 would carry the equipment experimentally over the North Atlantic from October 15 onwards. The PC-221A, superseding the earlier-announced PC-201 Radan, is a modification of the military AN/PN-102 and has a combined aerial/receiver/transmitter unit weighing 36 lb. The frequency tracker is housed in a ½ ATR case; and this and the groundspeed and drift indicator and control panel bring the total weight up to 89 lb. The company estimates the cost at $25,000. PC-221A has 74 sub-miniature valves, with both soldered and pinned bases. Airline valve requirements may cause a change, possibly to transistorization.

Arinc issued a specification for a purely civil Doppler navigator in July, and this is expected to be finalized in November. Both Canadian Marconi and Bendix Radio are preparing Doppler equipment for civil use, the former company using continuous-wave techniques, a fixed aerial and voltages lower than most so far announced. Early British Marconi Dopplers use pulse radar, while the Decca equipment (reported in America to bear the military code-name Yellow Lemon) uses a long pulse system.

The Ryan Aeronautical Company has made successful tests with its improved automatic navigator which is presumably of the Doppler kind. Called Model 108 (replacing the earlier Model 103), the equipment is installed in an L-20 Beaver, gives groundspeed, drift and position co-ordinates, and computes course and distance to a preset destination. It is lighter than earlier models and can operate at heights above 23,000ft.

THREE MUSKETEERS, who live as much by thrust as did Athos, Porthos and Aramis themselves, are these pilots of the de Havilland Engine Co., responsible for the development flying, in two Canberras, of the Spectre rocket and Gyron Junior turbojet. (Their co-ordinated demonstrations at Farnborough were carried through with true Dumas dash), R. to L.: J. M. Nicholson (chief test pilot), R. Plenderleith and M. C. Muir.

Thor Launch?

A LARGE missile fired from the U.S.A.F. base on Cape Canaveral, Florida, on September 20 is generally believed to have been a Thor, of 1,500 mile range. Should this have been the case, the launch would have been the first successful firing of this weapon. Among the spectators was Deputy Defense Secretary Donald A. Quarles.

Mach 2 Before Take-off

A ROCKET-SLED weighing 9,400 lb at the start has reached a speed of 2,600ft/sec (1,800 m.p.h. or Mach 2) on the 12,000ft-long SMART track on the Hurricane Mesa plateau in Utah. The vehicle was not arrested and flew for 1½ miles after leaving the track, which ends at the lip of the cliff.

Swedish Jindiviks

NINE Jindivik pilotless drones have now been shipped to Sweden from the Government Aircraft Factory in Australia. Control equipment and spares are also involved, and Swedish and Australian technical teams are exchanging visits. The first of a batch of ten was sent in January.

The D.H. Strike

AS the result of a meeting last Sunday at the Ministry of Labour under the Chief Industrial Commissioner, Sir Wilfred Neden, the proposed ban on handling de Havilland components at London Airport—in support of the strike by about 1,600 D.H. draughtsmen and planning engineers who are claiming an extra week's holiday with pay—has been suspended until next Sunday. But the strike (which started on September 16) spread when joined last Monday by 1,500 supervisors and inspectors, a move which —it was claimed—would bring to a standstill all D.H. factories.

In a statement issued before the Ministry of Labour talks began, de Havillands said that reports by the Unions that the company had refused to negotiate were "quite untrue."

Selling the E.P.9

JUST back from his sales tour of Australasia in the Edgar Percival E.P.9 agricultural aircraft G-APAD is Mr. Beverley Snook. During his three months in the Commonwealth he visited every one of its cities and carried 353 passengers on 323 flights, some 200 of which were special demonstrations; his air mileage was around 18,000. "The E.P.9 attracted exceptional interest in both Australia and New Guinea," he reports, "and orders were placed for ten aircraft, with further prospects for at least another 20 in the very near future."

The demonstration aircraft was purchased by an operator in New South Wales, and should by now be busy on top-dressing work.

Recent Appointments

AMONG appointments which have recently been announced are those of Mr. Eric H. Smith, D.C.Ae., Grad. R.Ae.S., Grad. I.Mech.E, as chief technician, Baynes Aircraft Interiors, Ltd., Langley; of Mr. P. E. G. Bates as commercial manager of Bristol Aircraft, Ltd., in succession to Mr. F. E. Davey, who has retired from that position; and of Mr. J. A. Airey and Mr. J. B. Waite as sales manager, guided weapons, and technical sales liaison officer, guided weapons, respectively, following a reorganization of the sales division of de Havilland Propellers, Ltd.

Further reference to the Bristol and de Havilland changes will be made in our next issue.

VULCANS IN SERVICE

A VISIT TO THE V-FORCE DELTAS OF NO. 1 GROUP IN LINCOLNSHIRE

THE fact that Avro Vulcans have graduated from the Farnborough scene to the airfields of Bomber Command was emphatically demonstrated last week, when *Flight* visited No. 230 Operational Conversion Unit and No. 83 Squadron at Waddington, near Lincoln. Behind the bird-like deltas lay the successful completion of the first thousand-hour period of intensive flying with the R.A.F. while ahead was the prospect of their participation, together with Vickers Valiants, in the U.S.A.F. Strategic Air Command's bombing, navigation and reconnaissance competition in Florida next month.

The first R.A.F. unit to operate Vulcans was No. 230 O.C.U. at Boscombe Down in August 1956. Since then this unit has moved to Waddington, where it is commanded by W/C. Frank Dodd, D.S.O., D.F.C., A.F.C., and where the first conversion course began in February of this year. The first Vulcan squadron to be formed was No. 83—the only operational squadron at present; No. 101 will follow in the near future; and among the later Vulcan squadrons will be No. 617, the famous "Dam-buster" unit which was disbanded (as a Canberra squadron) in December 1955.

Among the many officers who spoke highly of the Vulcan at Waddington (where our host was the station commanding officer, G/C. S. L. Ring, D.F.C.) were A.V-M G. A. Walker, C.B.E., D.S.O., D.F.C., A.F.C., Air Officer Commanding No. 1 (Bomber) Group; and the commanding officer of the O.C.U. A.V-M. Walker said that, from both operating and maintenance viewpoints, the Service was extremely pleased with the aircraft. The small number of snags experienced in bringing the Vulcan into service was most gratifying, and the aircraft was giving a utilisation rate better than that of any other aircraft, large or small. W/C. Dodd commented "We think it's a winner. It looks right and we think it is right." The delta was docile and gentlemanly in its handling characteristics, he added. The quality of the end-product of the O.C.U. had been demonstrated when, only three weeks after passing-out, aircrew from 83 Squadron had gained four awards in the 1957 Bomber Command Bombing and Navigation Competition.

The Under-Secretary of State for Air, Mr. C. I. Orr-Ewing, who had come to Waddington to wish the S.A.C. competition crews well, disclosed that No. 617 Squadron would be re-formed early next year and would be equipped with Vulcans. Scampton would again be the Dam-busters' base. Mr. Orr-Ewing also said that the Vulcans and Valiants which were to visit the U.S.A. would take part in a fly-past before the Queen at the Jamestown Festival.

From W/C. Dodd and the O.C.U. staff at Waddington we learned something of the selection and training of the Vulcan crews. The aim of the O.C.U. is, simply expressed, to train crews to operate the Vulcan efficiently to its limits under all-weather conditions. A complex aircraft to operate, the Vulcan demands close-tolerance work and high efficiency from all its crew-members.

Each Vulcan carries a crew of five, consisting of captain, second pilot, navigator/radar operator/bomb-aimer, navigator/plotter, and air electronics officer. Standards of crew selection are high. To be eligible, captains must have "above average"

flying ability, have flown 1,750 hr as first pilot and have completed a Canberra tour of duty, and four-engine experience is desirable. Second pilots must have flown at least 700 hr as first pilot and have completed a Canberra tour. Navigators also must have completed a Canberra tour (bomb-aimers, in addition, will have undergone the Bomber Command course at Lindholme), and A.E.O.s must normally have flown a tour of duty with Bomber, Transport or Coastal Commands. Other A.E.O.s come from the Air Electronics School at Swanton Morley after they have graduated from the Royal Air Force Technical College at Henlow.

Responsible to the commanding officer of 230 O.C.U. (who is also the chief instructor) are the chief flying instructor, W/C. C. C. Calder, D.S.O., D.F.C.; the chief ground instructor, S/L. Alexander Maisner, A.F.C.; and specialist departmental heads for navigation, weapons, air electronics, flight simulator and I.L.S. The training syllabus of the O.C.U. is divided into three phases, the first of which consists of four weeks' ground school. During this period pilots are instructed on aircraft performance and systems with an emphasis on flight planning and cruise control. Working models and sectioned components are used to demonstrate the various systems in the aircraft, and to show, for example, how to control fuel consumption so as to keep the aircraft within its c.g. limits.

Second pilots are instructed in their particular responsibilities, which include management of the fuel system in the air, control of cabin pressurization and recording of engine conditions. Navigators and A.E.O.s—the latter include signallers' duties among their tasks—receive instruction on their respective duties as applied to the Vulcan. Towards the end of this period pilots are introduced to the Vulcan flight simulator.

Two weeks of combined ground school and flying form the second phase of the course, followed by a final six weeks devoted solely to flying. The first instructional flight in the Vulcan consists of a two-hour demonstration of its handling at high altitudes, followed by landings. After this comes a short cross-country flight and a demonstration of emergency systems. The first "solo" flight (trainee captain and his own second pilot) is the third exercise.

Total flying time during the course comprises 55 hr on Vulcans (in 14 sorties, of which about half are at night, and including a number of long-range navigational exercises as far afield as the Atlantic and the Mediterranean), and a preliminary 10 hr on Canberras devoted to I.L.S. exercises. Each flight exercise is followed by a thorough debriefing analysis.

In the training of pilots the Vulcan flight simulator is an important facility—as one realizes when told that the aircraft's initial pre-flight check list contains 108 items, engine-starting involves a further 31, taxi clearance another 27 and take-off a further 21. More obviously important is the use of the simulator in teaching pilots to fly the aircraft—at an hourly operating cost estimated as one-tenth of that of flying the Vulcan—and to handle emergencies and instrument procedures.

The Vulcan simulator in use at Waddington, the first of a number being built by Air Trainers Link, Ltd., of Aylesbury, incorporates an exact replica of the pilots' cabin, in which a crew's captain and second pilot receive instruction simultaneously. Before their first flight in a Vulcan, pilots carry out seven exer-

Avro Vulcans (4 Bristol Olympus turbojets) of No. 83 Squadron and No. 230 Operational Conversion Unit of Bomber Command, seen (left) during a flight over Lincolnshire and (below) on the ground at R.A.F. Waddington. The shield on the fin is the station badge; in the background below is the Electronics Section—a scene of particular activity on a Vulcan station.

cises, totalling 15½ hr, in the simulator; and spend a further 7 hr on the simulator during the remainder of the O.C.U. course.

The simulator, it is claimed, is in many ways the most advanced device of its type. An outer shell surrounds the nose canopy and contains variable lighting in order to reproduce day or night conditions, independently of the lighting in the simulator room.

The instructor sits in an enclosed fuselage extension behind and slightly above the pilots. On his right and left are consoles with automatic map recorders of different scales, together with controls and switches for initiating a variety of emergency conditions and for adjusting such flight data as atmospheric conditions, fuel and armament loads, and c.g. position. The only flight sensation not reproduced is that of g.

For the navigators and A.E.O.s, although there is no complete simulation of their section of the aircraft, separate ground installations are used for training in the use of their respective pieces of airborne equipment. At Waddington we were not allowed to visit the electronics section (a well-designed, functional and isolated block), nor the radar/bombing training installation. In the O.C.U. ground school, however, we watched navigator/plotters hard at work (on their final practical examination) at mock-up positions in which their actual equipment was fitted; this equipment was seen to include Marconi AD.2000 Doppler units, on which the indicated groundspeed was 550 kt.

The Service's favourable general opinions of the Vulcan have been quoted earlier in this article, and there is approval, too, for the detailed points of the design. Power-operated controls are fitted, with no provision for manual reversion. Artificial feel is provided by a boxed compressed spring (located between the control column and the flying-surface power unit) against the action of which the pilot's fighter-type control column is moved. Changes in indicated airspeed are fed into the feel-box in order to adjust the tension on the spring. In the event of failure of the feel system with the spring at maximum compression, low stick forces for landing can be obtained by operating relief feel buttons in the cockpit.

The 14-tank fuel system is not unduly complex, and tank timers which control the fuel flow to the Olympus engines are fitted to assist in maintaining a correct c.g. sequence. A tapping from each powerplant provides an air supply for air-conditioning, heating, and anti-icing for engines, airframe and bomb-bay; and a variable degree of pressurization is available.

Cockpit layout is compact. On the main instrument panel the blind-flying instruments are duplicated and in front of each pilot. The engine control panel and the throttle quadrant are centrally located. Between the pilots' seats is a hinged arm which carries the autopilot and fuel-selection controls; this is pulled out and back for use.

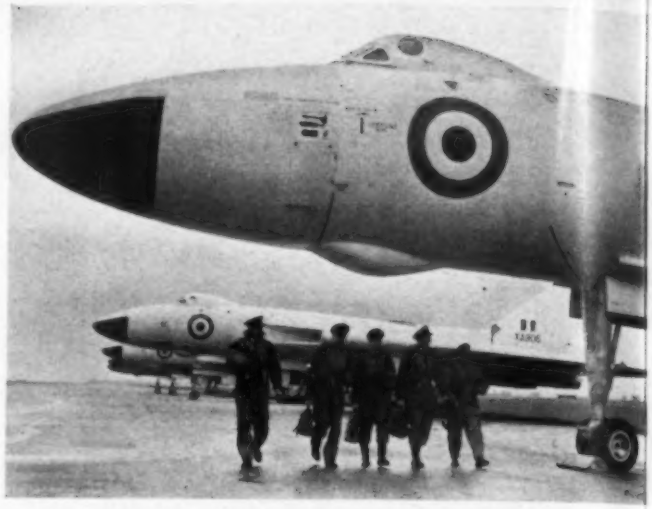
Electrical power is an essential service, and there are 102 electric motors and actuators in the aircraft. Power comes from four generators (one working off each engine) giving a total output of 90,000 Watts. In the event of three generators failing, essential services can be maintained on the remaining one.

The comprehensive radar, navigation and bombing system of the Vulcan is a notable product of the weapon-system concept and was developed simultaneously and integrally with the aircraft itself. Details of the equipment are secret at present. It can be pointed out, however, that such an installation was made possible by three factors: (a) advances in fundamental radar theory at the Royal Radar Establishment (previously T.R.E.), (b) similar advances in navigation theory and bomb ballistic computation at the Royal Aircraft Establishment, and (c) major developments in technological skill in the electronics industry. In the case of the Vulcan the work of developing, designing and producing the equipment was shared by several leading firms, among whom were E.M.I. Electronics, Ltd., who developed the radar system.

On the aircraft servicing side, each Vulcan has its own crew chief, normally an aircraft fitter, who has undergone a long period of specialist training on the type. Advanced tradesmen in the servicing teams have completed courses with the manufacturers, and the mechanic tradesmen have undergone training at a special school at Waddington. To accommodate the servicing needs of a new and complex aircraft such as the Vulcan, comprehensive facilities and new techniques have been introduced. This side of the work at Waddington is the responsibility of the station's senior technical officer, W/C. William Goodridge, M.B.E.

Crews for the three Vulcans which (together with three Valiants from No. 3 Group) will be flown to the U.S.A. for the S.A.C. competition at Pinecastle, Florida, next month, have been chosen from No. 230 O.C.U. and No. 83 Squadron. The three crews will be captained by W/C. A. D. Frank, D.S.O., D.F.C., commanding officer of 83 Squadron; W/C. C. C. Calder, D.S.O., D.F.C., chief flying instructor of No. 230 O.C.U.; and S/L. D. R. Howard, D.F.C., A.F.C., a flight commander of 83 Squadron.

On the occasion of the Waddington visit, the Avro company



A Vulcan's five-man crew comprises captain, second pilot, navigator (radar and bomb-aiming), navigator (plotter) and air electronics officer.

stated that official trials had given "good reason to believe" that the Vulcan was the fastest operational bomber in the world today. From the receipt of specification to the start of squadron service, the company also stated, the time taken for the Vulcan was nine years and eight months, compared with nine years and four months for the Boeing B-52.

The V-bomber specification was issued in January 1947. In general terms this called for a bomber capable of carrying a nuclear war-load over unprecedented ranges while flying at extreme altitude and within a small fraction of Mach 1; and capable of operating from normal bomber airfields. First studies made by Avro on a swept-wing type to meet the specification implied an aircraft twice the weight and size demanded by the R.A.F. A modified design in which tail and rear fuselage were not incorporated led to a project which again was overweight, this time by some 50 per cent.

It was decided to select a delta configuration, and this proposal was officially put forward in March 1947. During the summer of that year the original concept of an all-wing design having a rudimentary fuselage for the crew gave way to a new arrangement with a thinner wing and a full-length fuselage which faired in well with the delta shape. The tender for the Vulcan was accepted in November 1947.

During 1948 the flying-control system was modified (elevons were replaced by conventional elevators and ailerons) and wing-tip fins and rudders were replaced by a central fin and rudder. The basic configuration of the aircraft was finalized by September 1948.

To reduce the amount of prototype testing and to prove the basic concept of the tailless delta, it was decided to build and fly the Avro 707 series of small, single-seat research aircraft. The first of these, intended to explore low-speed characteristics, was designed and built in only 14 months. It first flew in September 1949 in the hands of Eric Esler, who was killed in an accident which destroyed the machine during the following month.

Modifications which flight-testing of the 707 had shown to be necessary were incorporated in the second high-speed machine, the 707B which Roly Falk flew for the first time in September 1950. Three further 707 variants were built. The prototype Vulcan (at that time known only as the Avro 698) first flew in August 1952.

The construction of the Vulcan prototype had been handled in an unusual way. Although the design was ready for detailed drawing-office work to begin in 1948, it was decided to wait until more of the basic theory was proved (the 707 programme being under way) before starting on such a large commitment. This breathing-space provided time to work on secondary problems so that a peak force of nearly 200 draughtsmen was available for

Vulcan Development, 1947-1956

Date	Occasion	Period from receipt of specification
Jan. 1947	Receipt of specification	—
May 1947	Submission of tender	5 months
Nov. 1947	Acceptance of tender	11 months
Jan. 1948	Order for two prototypes	1 year 0 months
May 1948	Design of 707 started	1 year 5 months
Sept. 1949	First flight of 707	2 years 9 months
May 1950	First detail drawings for Vulcan issued	3 years 5 months
Sept. 1950	First flight of 707B	3 years 9 months
July 1951	First flight of 707A	4 years 7 months
Aug. 1952	First flight of Vulcan prototype	5 years 8 months
March 1956	First production Vulcan for trials	9 years 3 months
May 1956	Initial acceptance	9 years 5 months
Aug. 1956	Vulcans enter service with R.A.F.	9 years 8 months

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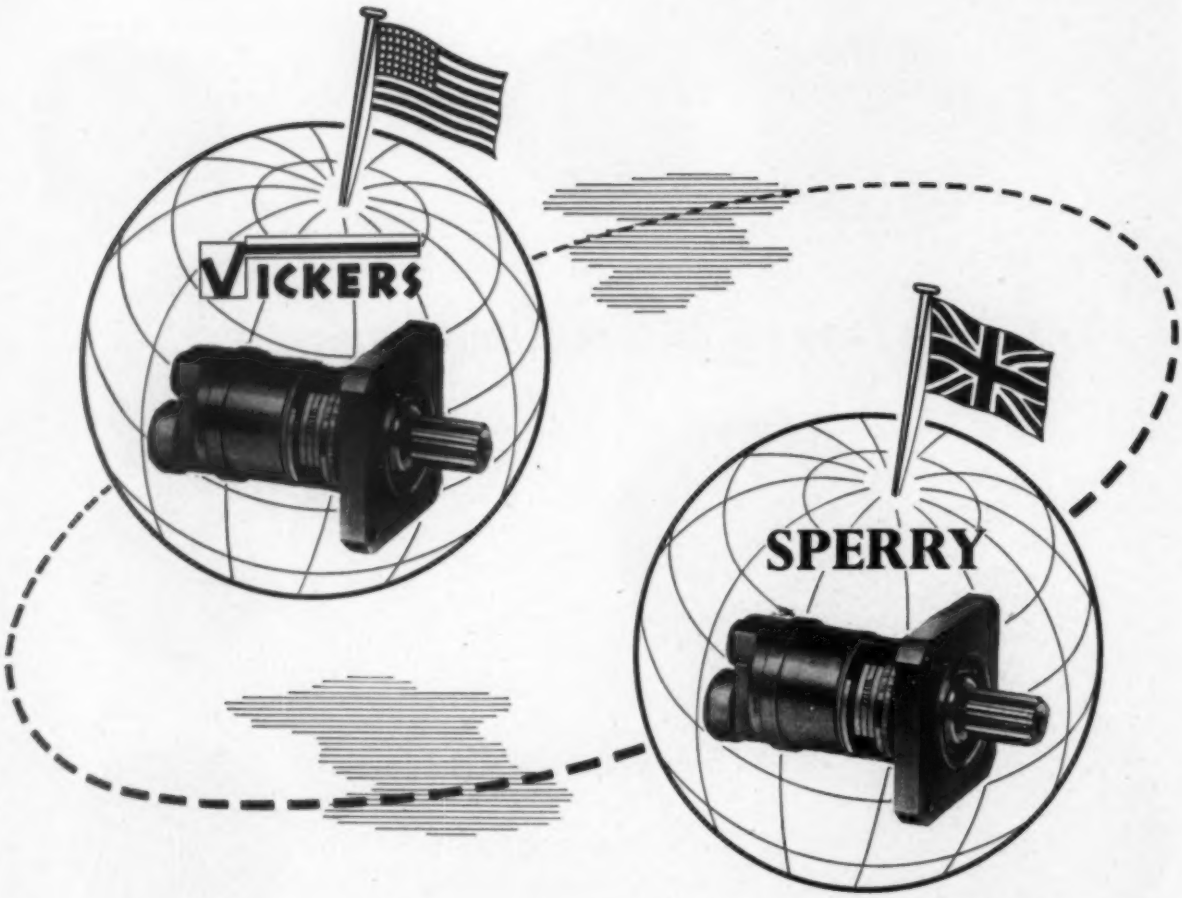

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A Vulcan B.1 undergoing a minor inspection at Woddington. Most servicing operations are performed from beneath the aircraft.

Vulcans in Service . . .

the major effort. Even after the design was frozen in late 1949, the results of R.A.E. wind-tunnel tests were awaited and major changes to the wing were made.

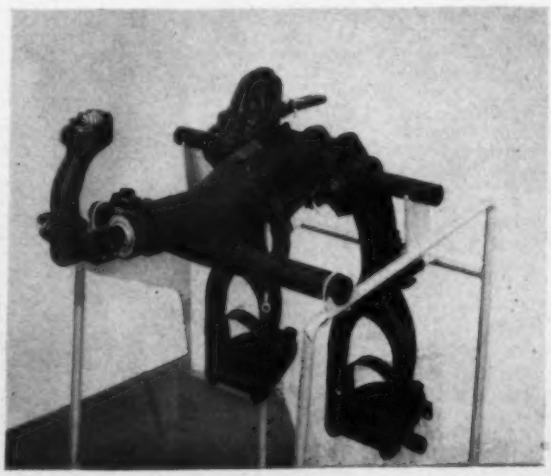
The company has said that "this patience in the early days saved incalculable time and money later." If the first prototype had been tooled up for production in 1948, the cost of changes later would have amounted to that of the whole 707 programme and these changes would have caused delays at the present time. Similarly, the second prototype Vulcan was held up and brought fully into line with changes made to the first after flight experience, with the result that it represented a production aircraft and set in motion the production line.

The first production Vulcan was delivered for preliminary acceptance trials in March 1956; initial acceptance was in May; and the aircraft began service with the R.A.F. in August of that year. A leading part in the test programme leading to the initial acceptance was played by the company's Flight Research and Development Department, a self-contained unit whose effective and streamlined organization was introduced by Sir William Farren.

Production of the Vulcan is now approaching its peak rate. This means that the programme has been timed to permit the equipping of the remaining R.A.F. Vulcan squadrons at progressively shorter intervals. The company states that 50,000 special tools have been required to put the first Vulcan squadron into service, and that each aircraft consists of 167,063 separate parts (excluding engines, nuts, bolts, rivets, etc.).

Other statistics announced by the manufacturers include the following. A total of 39,500 drawings was required for the Vulcan project from the start of the 707 series to completion of the basic Vulcan. Total drawing-office man-hours on the project were 1,467,000. The Vulcan contains 410,300 nuts, bolts, washers, etc.; metal sheet sufficient to cover 1½ football pitches; 9,362ft of tubing; 14 miles of electric cable; and 2½ miles of rolled sections. In addition to the Avro production line, 17 sub-contractors are building airframe parts. A total of 39,600 bought-out items is involved, from more than 400 suppliers.

Shown on the Wilmot Breeden stand at Farnborough was the Vulcan pilot's control installation, of which the pistol-grip—for an aircraft of this size—is a unique feature.



For two years, teams of Avro specialists ranging from test pilots and engineers to teachers, artists and writers have been engaged on the job of getting the Vulcan into R.A.F. service. This work has included that of the company's apprentices, who have put in 10,000 man-hours on the construction of working models of Vulcan internal systems for the instruction of R.A.F. pilots.

A special instructional school at Woodford has trained 300 Bomber Command technicians and over 30 from the R.A.E. and A. and A.E.E. during the past 18 months. Courses which required only two weeks to qualify servicemen on the Shackleton are, for the Vulcan, of 12 weeks' duration. The school's instructors are teaching airframe, electrical and instrument maintenance with technical data that took over a year to collect into more than 700 foolscap pages of notes. In addition they are training R.A.F. instructors, and pilots, engineer officers and other key men in Bomber Command.

The company's technical publications department is producing almost 1,000 5ft × 4ft hand-coloured instructional diagrams, incorporating 13,500 display panels hinged to show internal details. The department has also written and produced three volumes of lecture notes, a 1,200-sheet spares schedule, two volumes (1,000 pages) of descriptive and maintenance notes, and the pilots' notes.

A comprehensive ground-rig test programme was completed on the Vulcan, in addition to the normal prototype testing and the tests of the 707 aircraft. A complete airframe was built solely for ground-test purposes and was subjected to two years of thorough load-testing, and other rigs were constructed to test the hydraulic systems, pressurization and air conditioning, powered flying controls, fuel system and engine installation. Other items of research equipment installed by the company included a transonic and supersonic wind-tunnel, high-altitude and low-temperature pressure chamber, electronic flight simulator and a digital computer.

The head of the team responsible for the Vulcan is Sir Roy Dobson, managing director of A. V. Roe, who has made himself personally responsible for all major decisions covering the design, development and production of the aircraft. The technical director of the company in the early months of the conception of the design was the late Roy Chadwick, and his position was later taken over by Sir William Farren.

The chief designer of the Vulcan was S. D. Davies, whose right-hand men during the critical research and development phases were G. A. Whitehead, Vulcan project designer; and R. Connor, 707 series project designer. Today the Vulcan design team includes J. R. Ewans, chief designer; G. A. Whitehead, chief design engineer; P. L. Sutcliffe, chief aerodynamicist; and T. House, project designer. On the production side, under C. E. Fielding, works director, are A. Sewart, works manager; H. Dobson, works superintendent; and K. Beasley, aircraft controller. Co-ordinating, guiding and encouraging the teams working on all aspects of the Vulcan programme is J. A. R. Kay, general manager, while Roly Falk, superintendent of flying, has headed the delta flight-test programme since 1950.

PORT OF CALL: Visiting U.S.S. "Saratoga" in the Clyde, this Westland Dragonfly of the Royal Navy is seen in company with an HU-2 helicopter, McDonnell Demons (right) and Douglas Skyrays. Together with 75 other British and American warships, "Saratoga" is participating in NATO exercise Strike Back.

HERE AND THERE

Comet "Firsts"

A D.H. Comet 2 of R.A.F. Transport Command landed at Lyneham on September 17 after making the first direct Atlantic crossing—from Goose Bay, Labrador, in 5 hr 7 min—and the first Pacific crossing by R.A.F. Comet. It had been conveying Air Marshal Sir Andrew McKee, A.O.C.-in-C. Transport Command, on a tour of the Far East and had made the out-and-return flights *via* the U.S.A. and Honolulu.

M.o.S. Appointment

THE Ministry of Supply has announced that Mr. R. W. Pye has been promoted to deputy chief scientific officer and appointed Head of Trials Department, R.A.E.

Unified Location

A COMBINED aerial, pitot head and emergency-barrier hook capable of withstanding a 15,000 lb pull is being fitted to the Lockheed T2V Seastar, because it was found that the best location for these items is all in one place.

Gan Construction

A CONTRACT for building the air base at Gan in the Maldive Islands, which is to replace Negombo in Ceylon, has been let by Air Ministry to Richard Costain, Ltd. Work on this £2m project is to start next month and last about two years.

Soviet Missile

QUOTED in the Russian aviation magazine *Sovietskaya Aviatia*, Maj-Gen. G. I. Pokrovski said that the Russian ICBM could carry a hydrogen bomb warhead to within "six to 12 miles" of any target and that the launching sites required were very small and could easily be camouflaged.

For V.I.P. read D.V.

AS part of an economy drive, the U.S.A.F. has banned V.I.P. (very important person) and substituted D.V. (distinguished visitor). But the new regulation may not produce immediate economies as many V.I.P. signs and licence plates will have to be repainted.

Cranfield Research Grant

A TWO-YEAR research grant of £10,206 has been made to the College of Aeronautics, Beds, by the U.S. National Science Foundation for research into "the efficiency of information retrieval systems." A Washington announcement says that the work will be supervised by Mr. Cyril Cleverdon, the college librarian.

Commando on Canvas

AN oil painting depicting the landing of No. 45 Royal Marines Commando at Suez last November—the first occasion on which helicopters have been used by any country in a large-scale assault capacity (some 500 men were landed by Whirlwinds and Sycamores from H.M.S. *Ocean* and *Theseus* within 91 minutes)—is being sent to the Commando, now serving in Malta. It has been painted by Mr. W. H. Lane, a technical artist in the Admiralty.

Railway Technique?

TO increase the efficiency of its aerial fire-fighting force, the Ontario Department of Lands and Forests has developed a 90-gallon water tank and refilling device for its D.H.C.3 Otters. One of these tanks is fitted to each float, and they can be refilled in 18 sec while the aircraft skims the surface of a lake or river; an Otter fitted with them could deliver 1,800 gal an hour to a fire burning within two miles of the water supply-source. At the turn of a switch the containers revolve in their mountings and discharge their load over the fire. The new tanks are being adapted for use on Beavers also.

Forty Years On

NEXT month Mr. Graham Carey, who is 83, will take part in a commemorative flight (by DC-3) to mark the 40th anniversary of the first air-mail delivery in South Australia. This was carried out by Mr. Carey in a Bleriot 60, flying from Adelaide to Gawlor—a distance of 25 miles—on November 23, 1917.

Machine-tool Control

AUTOMATIC control of individual machine-tools through punched control-tapes or cards is a subject dealt with at length in our associated journal *Aircraft Production*. Existing British systems have already been described and, starting with the October issue, a new series of articles will be published on the major systems being developed in the U.S.A. These articles are the result of personal visits to the companies concerned.

POLISH WORKER: A prototype of the Polish Zuk helicopter, designed by B. Zurakowski, is seen (right) being assembled at the Institute of Aviation in Warsaw. The Zuk will serve as a crop-sprayer and ambulance.

OTTER AND COOLER: At left water tanks are seen fitted to the D.H.C. Otter for fire-fighting purposes (see paragraph above).

FIREFLASH

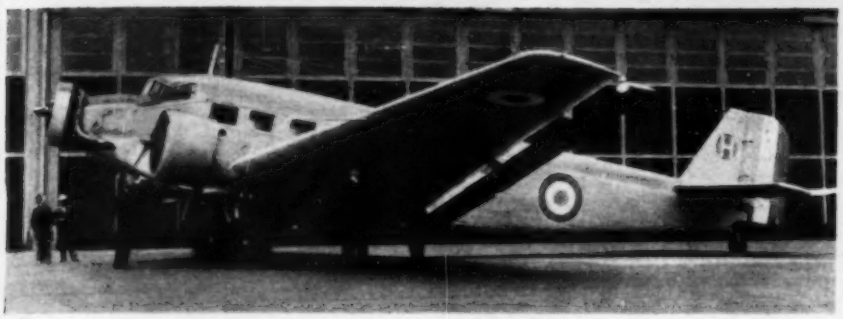
The only British air-to-air guided weapon that is in service with the R.A.F. now — proved, lethal and available.

THE FAIREY AVIATION COMPANY LTD
HAYES · MIDDLESEX

ENGLAND · AUSTRALIA · CANADA

Every 5 seconds of the day and night—the clock round, the year round, an international airliner takes off on a scheduled flight—6,307,200 movements a year—and one third of these aircraft are fuelled by **Shell's World-wide Aviation Service.**

SHELL



Transports tried and true: the Handley Page Hastings C.1, from the doorway of which the air-to-air pictures on pages 512-513 were secured; and the French-built Ju52/3m purchased (for one franc) from the French Air Force by the Deutsche Museum in Munich.

AIRCRAFT INTELLIGENCE

Great Britain

Hawker Hunter F.6. According to *Aviation Week*, the gross weight of the Hunter F.6 is 17,800 lb, and the overload gross weight 23,700 lb.

U.S.A.

Anti-submarine Aircraft. The U.S. Navy is reported to be favouring land-based aircraft for future anti-submarine work, although tentative instructions have been given to Convair for the development of a water-based three-engined machine. For a design competition now in hand Lockheed plan to submit a version of the Electra.

Convair B-58 Hustler. It is reported that when General Thomas Power, Chief of the U.S.A.F. Strategic Air Command, flew in a B-58 recently a Mach number of 2.09 was attained at a height of 50,000ft. For a period of more than thirty minutes, it is stated, the B-58 remained above Mach 1.

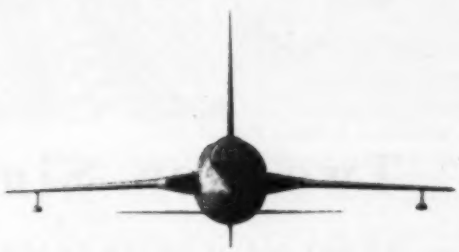
Lockheed L.1649. Operated by T.W.A. as the "Jetstream Starliner", the super-long-range Constellation is being refitted with propellers with solid light-alloy blades. The original blades, of the newly certificated hollow-aluminium type (Hamilton Standard), have given core trouble.

France

Industry Cutbacks? The French aircraft industry has been warned to prepare for reductions in military aircraft production orders and for the concentration of all missile work in one service, with a single test installation at Colomb Bechar. The intercepter programme appears to be largely intact, except that all Trident and Super Vautour production might be cancelled. The number of Vautour bombers ordered might be reduced from 200 to 160; and the Nord 2506 assault transport and Bréguet 765 heavy transport might be cancelled. Projected Potez 75 production is similarly threatened and helicopter production would be slowed down. A number of Morane-Saulnier 733 Alcyons would be dropped and the pre-production order for twin-engined Sipa 1100 ground-attack machines would be reduced from ten to two. Strong opposition can naturally be expected from the industry and these plans might not come into force in their entirety.

Marcel Dassault Production. Although the greater part of Dassault production is devoted to the Super Mystère B.2 (SNECMA Atar turbojet), Mystère IVAs of the Indian order for about a hundred are still leaving the production line. These have the Hispano-Suiza Verdon. When the Mystère IVAs are completed about 420 machines of the type will have been constructed. Six Mystère IVAs competed in the recent St. Exupery Cup race, and after covering the course of about 415 miles the aircraft finished within 13½ seconds of each other.

Fouga Magister. In collaboration with the O.F.E.M.A. organization Air Fouga have granted a licence to Israel for the construction of the Magister twin-jet trainer. The company concerned is Bedek Aircraft, Ltd., which has its workshops at Lydda airfield.



REPUBLIC F-105B THUNDERCHIEF
(Pratt and Whitney J75)

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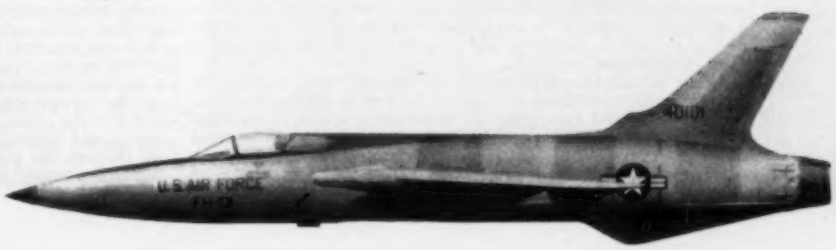
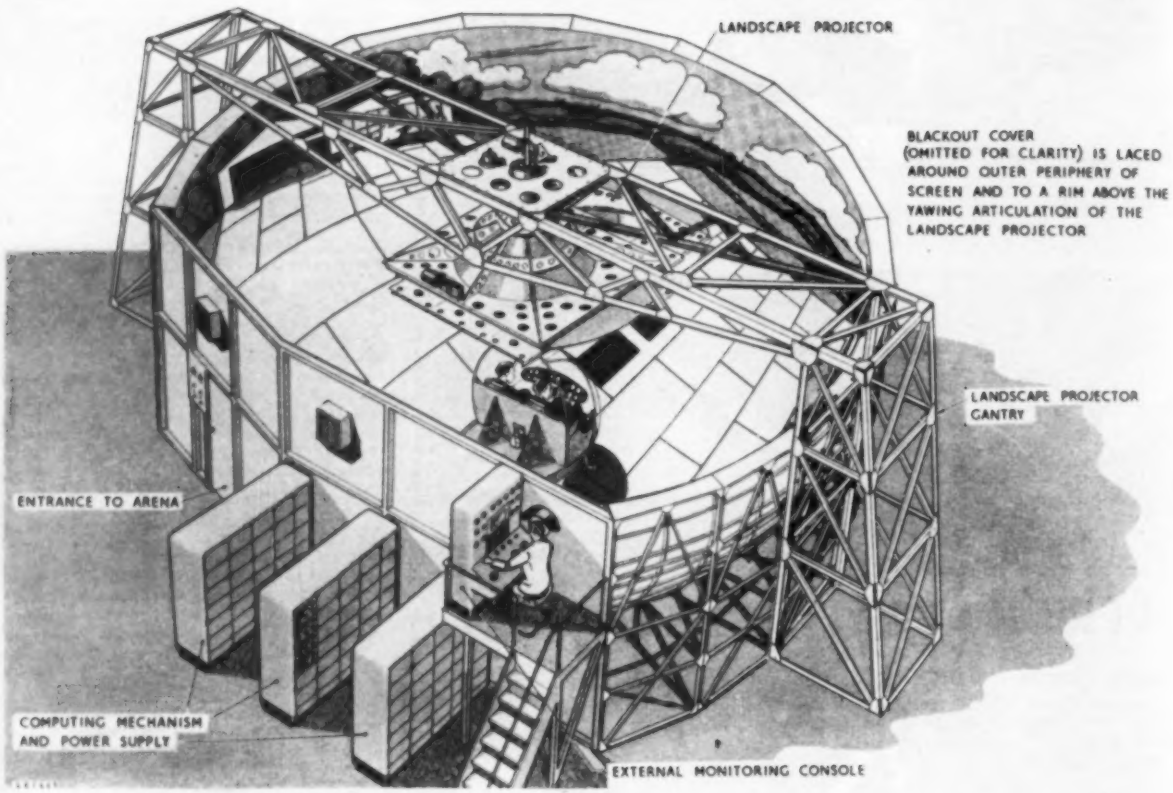
Length	...	...	...	63ft 1in




LANDSCAPE PROJECTOR
BLACKOUT COVER (OMITTED FOR CLARITY) IS LACED AROUND OUTER PERIPHERY OF SCREEN AND TO A RIM ABOVE THE YAWING ARTICULATION OF THE LANDSCAPE PROJECTOR
LANDSCAPE PROJECTOR GANTRY
ENTRANCE TO ARENA
COMPUTING MECHANISM AND POWER SUPPLY
EXTERNAL MONITORING CONSOLE

Two New Simulators

SHORT HELICOPTER TRAINER AND SPERRY CONTROL SIMULATOR

ONE of the major applications of new computing methods is in flight simulators of all kinds, whether designed as research tools or for training. Of the two new systems described here, one is a helicopter simulator for training purposes, which is now under final development by the research department of Short Brothers and Harland, Ltd.; and the other is a laboratory rig made by the Sperry Gyroscope Co., Ltd., for developing complete aircraft control systems to an advanced stage before the aircraft itself flies. The Sperry system is intended for research; while the Short device is a complete moving-base, visual simulator which can be adapted to represent any of a number of different existing helicopters. It uses D.C. computation.

The Short helicopter simulator is intended ultimately to incorporate a computing system capable of simulating a wide range of aircraft, including both current and future types. It can reproduce varying weather conditions and emergencies such as complete or partial engine failure.

Its main purpose is pilot training in primary and advanced helicopter flying, operational routines, emergency drills and instrument flying. It can simulate hovering, forward flight and autorotation, and transition from one to another of these conditions, and can be used for conversion to new types or for research into control and stability. Much time and money can be saved by using the simulator instead of actual helicopters for pilot training.

This new simulator presents to the pupil pilot most of the sights and sounds of actual flying, and many of the physical sensations. From the full-sized cockpit structure, supported on a universal mounting, he experiences the actual angular motion of the aircraft in hovering and is able to "fly" at will over a three-dimensional landscape.

Servo motors on the two axes of the mounting control the cockpit in pitch and bank according to electrical signals generated by the associated computers in response to demands received from the pilot's controls. The angular movements of the cabin cover most normal attitude changes. Apparent freedom in azimuth is unlimited, yaw being represented by traversing a colour image projected on a curved screen surrounding the cabin. This image surrounds the pilot with a landscape stretching to the horizon.

The image itself is a composite one cast by two projectors whose yaw motions are linked. The horizon projector, located below the cockpit, casts an image of the sky above the horizon line and of the land or sea below it, so that the horizon is always above the pilot's eye level. The landscape projector, mounted above the pilot's cockpit, throws on the screen the image of a landscape of limited area blending into the horizon image. Three-dimensional objects, such as hangars and trees, are included; and some of these project above the horizon when the aircraft is supposed to be at ground level. The landscape image moves according to the computed motion of the aircraft; and both images are rotated about the cockpit to show yaw. The scale of the landscape image and the perspective view of three-dimensional objects change to give the pilot a realistic impression of his movement relative to them.

Visual flights within an area of 360 yd diameter and up to 400ft are possible so that the pilot can make autorotative descents and emergency landings from "safety heights." But heights up to the ceiling of a particular aircraft type can also be simulated, with appropriate instrument readings and control response. The landscape shows a concrete landing strip about 150ft long, with the usual features, surrounded by typical countryside with trees and buildings. The projection screen surrounds the cockpit through 230 deg in azimuth and can be made in sections.

The cockpit has typical levers for collective pitch and throttle, cyclic control and rudder; and the rocking mechanism has ± 30 deg freedom about each of two axes at right angles, but is limited to ± 24 deg in pitch for space reasons. Cabin movement is controlled by two electro-hydraulic servomechanisms which provide a cockpit attitude proportional to voltage-signal demands made by the computing system. These high-response servomotors can give the cabin angular rates of ± 1.2 radians/sec. Electrical cables and hydraulic lines for instruments and services are led up through the central pillar of the supporting pedestal. The hydraulic supply for the servomotors is obtained from a high

pressure pump set housed in the base of the pedestal and operating on a 230 V, 50 c/s. mains supply.

The projectors work on the "Linnebach" or shadowgraph principle, using a special lamp as a concentrated light source to cast the shadow of the colour transparency on the screen. The horizon projector shows a distant view unchanged in perspective by the pilot's apparent movements; and the transparency is a two-dimensional picture on a cylindrical surface with a fixed lamp on the axis of the cylinder.

The landscape projector holds a semi-transparent model whose images change their perspective with the apparent motion of the aircraft because the rays of light from the point source lamp over the model follow the same path as would the lines of sight of a pilot whose eyes were at the light source.

If these rays are caught on a screen round the lamp the picture, viewed from a point close to the lamp, has the true perspective of the landscape as the pilot would see it. If the model is moved relative to the lamp, the picture on the screen will reproduce the perspective changes seen by the pilot when carrying out equivalent manœuvres. It is impossible for the pilot's eye to coincide with the lamp, but experience has shown that appreciable vertical separation between the pilot's eye and the lamp causes no noticeable distortion of the image. The projectors are in any case designed to minimize distortion.

The cylindrical transparency in the horizon projector can be yawed about its vertical axis by an electrical servo, according to the computed heading of the aircraft. It is painted to represent a comparatively featureless landscape viewed from a moderate distance, and has a level skyline with a few distant landmarks to serve as reference points.

The landscape may be of fields and woods with a daylight sky and clouds, or of a distant seascape for marine use, or a night sky and darker landscape for night training. It takes only a few minutes to change transparencies.

The landscape projector, mounted above the cockpit, consists of a circular three-dimensional transparent colour landscape model, nine feet in diameter at a scale of one inch to ten feet. It is mounted on a carrier running on rails which allow movement along the north-south axis of the model. These rails are carried on another pair of rails which allow movement along the east-west axis. The entire assembly is mounted in a bearing which facilitates unlimited yawing. The lamp can be moved from a position close to the plate—giving a scale height of about 8ft—to a scale height of about 400ft, the movement being controlled by vertical speed signals from the computer. The model is moved by electric servos controlled by velocity signals from the computing system.

The system is a network of electronic and electro-mechanical units which solve by analogy the various simultaneous equations of motion representing the behaviour of the helicopter. The computing channels consist mainly of integrating and adding units, together with a number of multiplier units for product formation, function generators to represent non-linear characteristics, and resolvers for trigonometrical operations.

The computer receives electrical input signals from potentiometers coupled to the cyclic and collective pitch controls, rudder bar and throttle twist-grip; and generates output signals representing aircraft attitude, rates and translation. These are in turn fed to the projector- and cabin-servos and to the simulated instruments. Various subsidiary computing loops are provided to represent the effects of variation of air density and pressure with height, the development of induced flow in the various regimes of rotor operation from the windmill-brake, through autorotation to the propeller working state, and the influence on this of forward flight and ground effect.

Noise generating circuits, monitored by the engine and rotor speed computing servos, synthesize the sound and vibration of the rotor and engine; and a rough air generator can be coupled into the aerodynamic block by the instructor, who can also vary the sea-level air density in order to simulate the effects of climate on performance.

The instructor, using controls at his external monitoring position or on a panel at the left side of the cockpit, can produce sudden emergencies such as complete, partial or progressive loss of engine torque, increase of rotor drag (caused, for example, in icing conditions) or deficiency of tail-rotor torque such as might be experienced if the tail rotor struck an obstacle.

The computer has a number of multi-bay racks, with standard 19in panels holding the various computing units, and a control console. All panels can be removed for easy maintenance, and the racks have inspection doors at the rear. The basic computing unit is a high-gain D.C. drift-corrected amplifier with low inherent phase shift, constructed as a flat unit with a built-in handle. Normally, ten of these can be plugged into one 19in panel. For cheapness and consistency of performance, printed wiring is employed wherever possible. According to the feedback network connected across it, the standard amplifier can be employed for addition, high-speed integration and various other functions.

For slow-speed integration and multiplication, and for function

Instructor's eye view of the Short helicopter simulator, showing the landscape model and horizon projector (at the top and bottom) and the moving-base cockpit section at left. The screen is bowl-shaped.

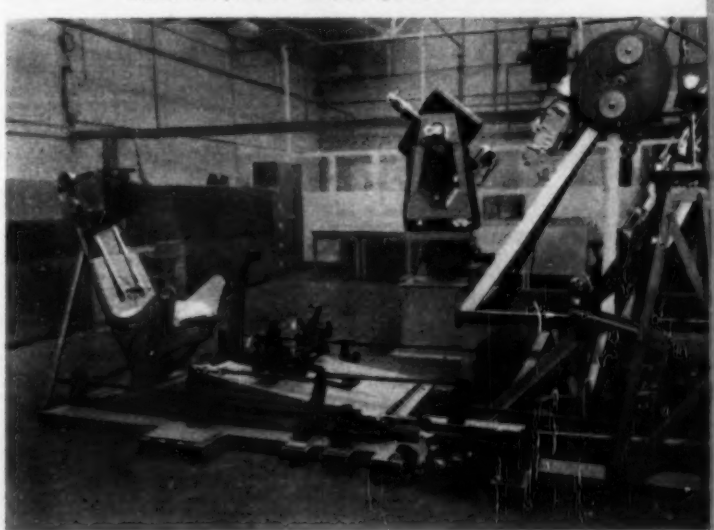
generation and resolution, the basic amplifier is used to drive an instrument-type motor generator with a high torque/inertia ratio coupled to low-friction potentiometers to form either a velocity or position-control servo.

The Sperry Control Simulator

With the Sperry simulator, it has been found possible to develop a complete aircraft control system to an advanced stage on a test rig before fitting it to an aircraft, thereby greatly reducing the usual flight-development period.

The technique has been devised by the Sperry Gyroscope Co. in connection with the development of its integrated control system. Although this system was primarily intended for high-speed aircraft, it was not desired to associate it with any one particular type. The simulator technique was chosen so that in the development stage the design parameters of any aircraft could be used in the test apparatus. Suitable adjustments and modifications were made progressively to ensure that the final version was correctly harmonized to the design characteristics of the air-

The Sperry control simulator rig, with pilot's controls at left, servo system at right and the moving table and gimbal system, representing the airframe, in the middle background.



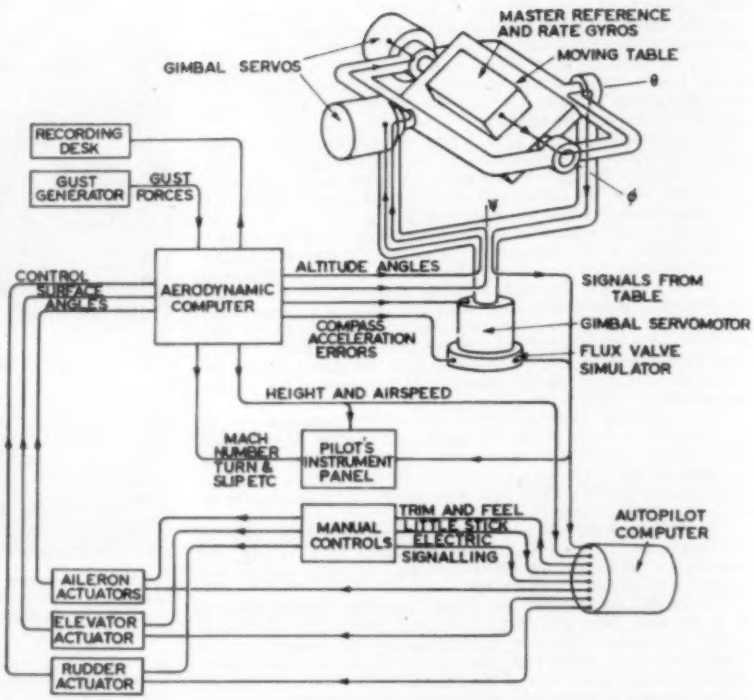
TWO NEW SIMULATORS . . .

craft for which it was eventually intended, whether it be a high-speed fighter or large passenger airliner.

As seen in the schematic diagram on this page, the characteristic feature of the equipment is a gimbal-mounted table, the motion of which is controlled by three hydraulic servo-motors. On the table, which takes up an attitude corresponding to that of the aircraft, are mounted the gyroscopes and other instruments, their outputs being taken through slip-rings to the central control device (perhaps most aptly described as the autopilot computer) and to a simulated blind-flying panel. The pilot's controls are coupled to the autopilot in the same way as in an aircraft, and control of the hydraulic actuators may be exercised electrically or by mechanical linkage as selected by the operator.

The hydraulic actuators drive loads which are adjusted to have the same aeroelastic properties as the actual control surfaces would have on a full-scale aircraft. To each control surface there is coupled a potentiometer from which voltages proportional to the control-surface angles are derived. These, together with signals from a gust generator, are fed into the input of an analogue computer; while the aerodynamic derivatives of the aircraft under test are set in on the panels of the computer. From the combination of control-surface angles and gusts fed in, the attitude of the aircraft is computed continuously as three voltages which are used to drive the three servo-motors on the gimbal table, thereby closing the simulation loop.

Other outputs of the analogue computer are height and airspeed, which are used to drive the small servo-motors geared to the instrument panel and to the barometric capsules in the autopilot computer. Further signals are Mach number and turn-and-slip signals for the instrument panel. A recording disc with six pen recorders and a twelve-channel photographic recorder is also provided.



The Sperry control simulator in block diagram form, showing the various control loops for manual, stabilization and autopilot control modes, together with the gimbal-mounted attitude reference system (shown semi-pictorially at top right).

The control system itself is designed as a fully integrated system to combine the facilities of autopilot, autostabilizer and electro-hydraulic power-operated controls in one comprehensive equipment. By integrating the three services, and thus avoiding unnecessary duplication of components, considerable simplification and weight-saving has been achieved. Reduction in weight follows automatically.

The autopilot computer, which embodies complete transistorization and the use of printed-circuit techniques, performs the function of autopilot and autostabilizer according to which mode of control is selected. It receives signals from three rate-gyros and from airspeed and altitude sensers and a lateral accelerometer mounted in the fuselage. A master reference gyro provides heading and pitch and roll angle signals; in addition, demand signals from the pilot's manual controls can also be fed into the system. The autopilot computer then sends out suitable signals to the hydraulic actuators which impart the appropriate movement to the control surfaces.

Four different control modes are available: "Direct" (mechanical), "Autostabilizer," "Rate Control" and "Autopilot." Facilities for reversion to direct mechanical control are provided for use in emergency in the event of electrical power failure. For the "Rate Control" mode, a separate miniature stick has been provided, as it was felt that having two significantly different control modes on the main control column might be disconcerting for the pilot. Movement of the miniature stick, it is stated, will automatically result in perfectly co-ordinated flight manœuvres, the necessary control-surface angles being automatically and continuously applied by the autopilot computer. The rudder pedals are used solely to produce side-slip if required, the basic rudder control signals in turns emanating primarily from the lateral accelerometer. The aircraft is flown entirely with the miniature stick.

Facilities available in the "Auto-pilot" mode include heading selection, Mach lock, height lock, flight-director coupling, I.L.S. coupling and coupling to weapons system. When "Autopilot" is selected, the aircraft will maintain the flight path it was following at the instant of engagement until a change is introduced by means of the trimming knobs.

Current design-studies for the new equipment include the investigation of its suitability for application to large helicopters. As a result of tests already completed, the manufacturers claim a high degree of accuracy and reliability for the equipment.

COVENTRY VICTOR FLYING NEPTUNE

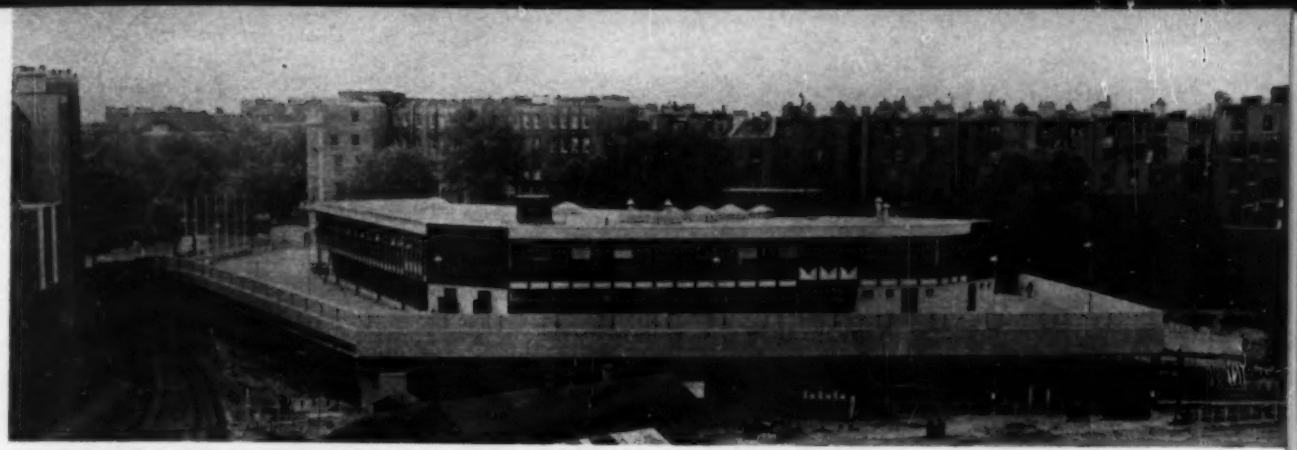
ON show to the general public for the first time, the Flying Neptune engine, built by the Coventry Victor Motor Company, Ltd., is a feature of the Popular Flying Association stands at the Arts and Handicrafts Exhibition which closes at Earl's Court, London, tomorrow.

The Flying Neptune is a conversion of the Neptune flat four industrial engine. The aircraft version was first subjected to a 50 hr test in a Piper Cub at Southend; and was flown at that time by *Flight's* representative (*Flight* for July 15, 1955). It is a flat-four, air-cooled unit, with wet sump lubrication, overhead valves and a capacity of 1,815 c.c.; and it gives 55-60 h.p. at 3,200 r.p.m. Bore and stroke are respectively 85 mm and 80 mm; and weight is about 210 lb. Continuous cruising power is 44 b.h.p. at 2,600 r.p.m. The combustion chambers are hemispherical and the valves are inclined—a feature which is largely responsible for the especially good fuel consumption of 0.45 pt/b.h.p./hr. A twin-magneto ignition system has now been fitted.

The Flying Neptune is remarkable for its smooth running and good throttle response; and one example has given excellent results when installed in a Turbi. It takes both prolonged running at full throttle and long climbs in its stride. The engine was converted as a personal private venture by Maj. W. A. Weaver, managing director of the Coventry Victor Motor Co.

SIDE-LOOKING, 3-COLOUR RADAR

A CONTRACT worth $1.4m (approximately £499,998) has been awarded to Texas Instruments, Inc., for a sideways-looking airborne radar which produces a three-dimensional, continuous picture in three colours of the ground over which an aircraft is flying. The new equipment uses transistors instead of valves where possible.



London's new city-centre air terminal, seen from the north-east.

"Flight" photographs

London's New Air Terminal

ON October 6 London's new city-centre air terminal comes into operation. Though this transfer from Waterloo to West London is not wholly voluntary—the South Bank building is due for demolition—the advantages of easier and quicker access to London Airport (the coach journey is expected to take 40 min or less) and improved passenger handling facilities are apparent.

The new terminal stands on a steel and concrete platform spanning the triangular railway junction adjoining Cromwell Road, between Earls Court and Gloucester Road stations; it marks the town end of the new Cromwell Road extension.

The erection of this platform was put in hand by London Transport in February last year. On completion it was handed over to the owners and sponsors, Air Terminals, Ltd.—a company originally formed by B.E.A. (who have an 80 per cent shareholding), B.O.A.C., B.I.A.T.A. and Aer Lingus.

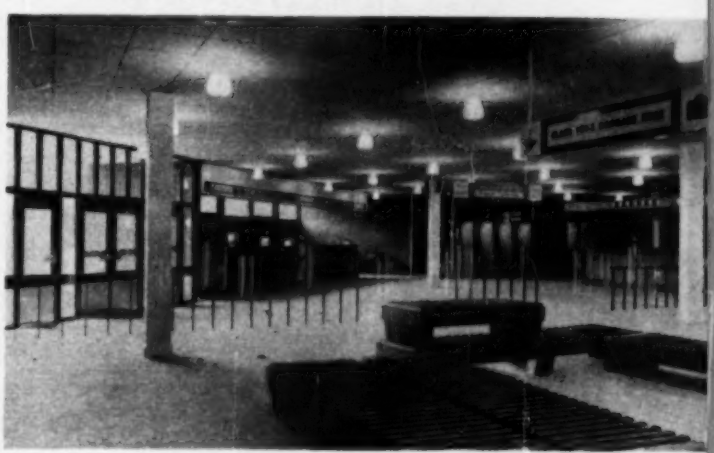
The terminal building itself—costing just over £250,000—is the outcome of close co-operation between the sponsors, the contractors (Richard Costain, Ltd.), B.E.A. and London Transport. The speed with which the building went up—it was finished in 3½ months, six weeks ahead of schedule—was largely due to its novel method of construction. Most of the parts were prefabricated and stored nearby ready for use.

The interior layout of the new terminal is simple. Outgoing passengers arrive at the departures hall on the ground floor, where their tickets are examined and luggage weighed at any one of 15 or so check-in desks. There is a special desk to deal quickly with the inevitable late-comers. Luggage goes by moving belt to the baggage hall for loading. The first floor is a waiting area, where refreshments (and drinks, at a licensed bar) are available. There is a pleasant lounge and several shops. Arrivals from London Airport are disembarked at the rear of the building and do not cross the track of departing passengers. Parking space on the platform is limited, but considered "adequate."

Air Terminals, Ltd., will control the various concessions, including catering, porterage, baggage-loading, maintenance, and so on. Passenger "processing" and transport to and from the Airport will be B.E.A.'s responsibility. Mr. J. O. Hutchinson has been appointed Terminal Manager.

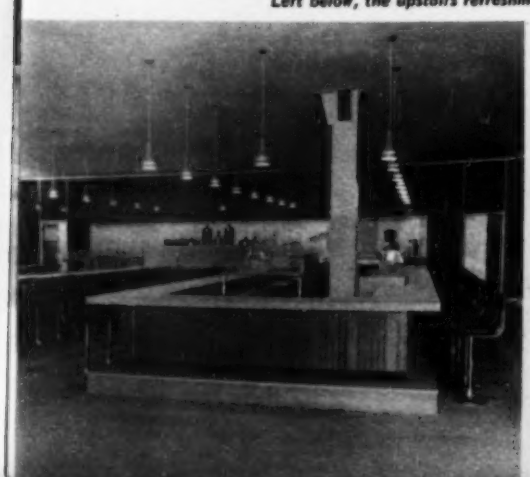
There are hopes at least that a permanent combined air station, with direct rail service to L.A.P., can be built at Victoria. The ideal—as at Gatwick—is to have an out-of-town airport terminal linked with London by rail.

Outward-bound passengers will enter this ground-floor departures hall.



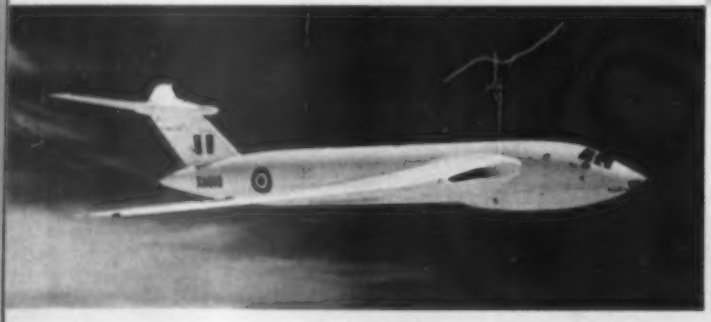
Passengers arriving will enter this separate area of the ground floor.

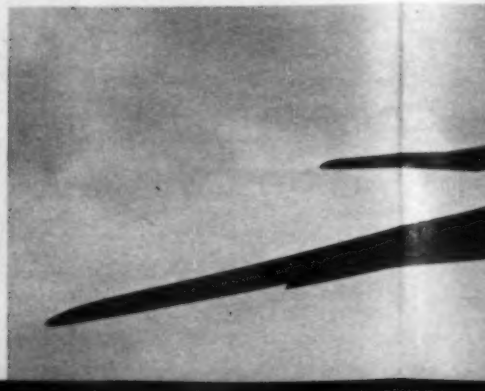
Left below, the upstairs refreshment bar; and on the right, the spacious lounge, of which the bar is a part.



VICTOR B.1

WHEN the first photographs of the original prototype of the Handley Page Victor B.1 medium bomber (four Armstrong Siddeley Sapphires) were released just before Christmas 1952, contrasting opinions were voiced respecting its appearance. Not everyone took kindly to the bluffness of form suggested by those early pictures; but as the Victor became a more familiar sight in the air, and especially when the gleaming-white Titanine anti-flash finish was applied, it took on a majestic grace that remains completely its own. Production-type Victors of this mark, as portrayed in these new *Flight* photographs, will soon be serving with the R.A.F.; and following them into production will come the B.2 development, with Rolls-Royce Conway by-pass engines.





XA918

AIR RADIO DEVELOPMENTS

A Year of Consolidation Rather than Invention

PROGRESS in the design of new air radio equipment has not been particularly marked during the past year—with one or two notable exceptions. The trend lies rather toward consolidation of gains made in a number of directions. A great deal of attention, both in Europe and America, has, for example, been focused on the provision of an airborne proximity warning or collision-avoidance device. But most companies engaged in the development of such equipment have met very severe difficulties; and an authority so eminent as Dr. Morrel, of Bendix Radio, has stated that "an effective self-contained airborne collision-avoidance system is now and will continue to be out of the question."

But the Jet Operations Requirements Panel of I.C.A.O., in particular, has commented frequently on the need for suitable means of achieving separation between aircraft.

It has become something of a fallacy to assume that the collision risk is at its greatest in terminal Control Areas and Zones. If anything the reverse is true. With radar surveillance the safe conduct of such controlled airspaces is in competent hands, although airspaces such as the London Terminal Control Zone and Area are rapidly becoming saturated—a fact which is, in itself, a considerable problem. The greatest danger of collision between aircraft in flight appears to exist either entirely outside controlled airspaces, or else on major trunk routes and, soon, over the North Atlantic.

Until the time comes when an efficient anti-collision aid is available the answer would appear to lie partly in the development of very accurate navigational aids with simple, continuous presentation. While such aids in themselves will not provide warning of the proximity of another aircraft, they will allow every aircraft to advise the A.T.C. authorities frequently of its position with a high degree of accuracy. Control can then originate suitable instructions to prevent dangerous collision risks from developing.

Apart from the collision problem, the introduction of jet aircraft in numbers on world air routes is going to present problems of another kind. J.O.R.P. has already stressed the problems relating to the high rate of closure of potentially colliding jet aircraft; and the lack of conspicuity at high altitudes of such aircraft in the collision sense. Other problems are anticipated in the navigational sense. These particularly include the climb to initial cruising altitude, the use of the cruise-climb technique, and the let-down. Both J.O.R.P. and the I.F.A.L.P.A. have concluded that an uninterrupted climb and descent are definite requirements for jet aircraft, and that stringent traffic-control methods are going to be necessary. Both these organizations recommend the development of a navigational aid based on area coverage, providing the pilot with a pictorial cockpit presentation. In addition, an accurate indication of distance to go is needed. J.O.R.P. also consider the unduly high lateral separation minima in use on the North Atlantic, noting that the present separation systems would be economically unacceptable for jet aircraft.

In view of these problems and requirements it was more than encouraging to see displayed at Farnborough this year the new, completely integrated navigational system for contemporary aircraft known as D.I.A.N. This new aid provides in one installation a complete navigation system for long and short ranges, with a very high degree of accuracy. On the face of it, there are good grounds for believing that this aid will completely meet J.O.R.P. and I.F.A.L.P.A. requirements. The first general details of D.I.A.N. were given in *Flight* for August 23.

The ordinary Decca Navigator system is now very well known. Development has progressed to the Mk 10 equipment, in which the earlier zone ambiguity factor has been eliminated. The Mk 10 provides fully automatic lane identification, together with zone identification signals enabling the zone identification indicators to be set manually from radiated information—and not, as before, from dead reckoning information. Another very important factor in the Mk 10 is that by virtue of the multi-frequency pulse technique employed, night effect is reduced and the approved night range of the new Decca is 240 n.m., instead of 150-180 n.m. as before. The accuracy of the Decca system, of whatever version, is such that, with Flight Log presentation, reduced separation standards for Decca-equipped aircraft flying within U.K. controlled airspaces has been approved, and special expediting procedures introduced.

Decca's long-range brother, Dectra, has now successfully been in operation for some months, completely covering the Prestwick-Gander route. Based on conventional Decca principles, Dectra provides highly accurate tracking and ranging information, again with Flight Log presentation. In fact, the same Flight Log may be used for a combined Decca and Dectra installation. Essentially, Dectra provides a number of accurately delineated tracks along a given route, together with distance gone, distance to go and diversion information. On the North Atlantic route the tracks are 5 n.m. apart up to 100 n.m. out from either terminal, and 30 n.m. at mid-route. Such accuracy, when conclusively established, means that very considerable reductions in present lateral-separation minima for this route will become possible, together with a reduction of the already unacceptable collision factor. In *Flight* for June 7 an account of the preliminary trials of Dectra was given. A reproduction of the Flight Log chart used on one crossing revealed an off-track error at 31 deg W of only 1½ n.m.

As for weights and size, the complete Flight Log, with its associated control box and computers, weighs 58 lb and takes up 3.45 cu ft of space. The Mk 8 receiver, complete, weighs 65 lb,

The Decca D.I.A.N. system components as displayed (left, below) at the S.B.A.C. Show. The Doppler aerial is on the right of the picture and dials and black boxes on the left. Right, the Marconi AD.2000 (upper) and AD.2100 Doppler radars, also shown at Farnborough.

"Flight" photographs

while the new Mk 10 receiver and power unit weighs 83 lb. The total weight of a Dectra installation is about 146 lb, but much of this is common to both systems, so that a combined Decca-Dectra installation should not weigh much more.

Now comes D.I.A.N., the joint product of the Decca Navigator and Radar companies. Recognizing that as yet Decca and Dectra have not achieved universal coverage and that a certain amount of ionospheric effect exists which can, at its worst, be only minimized (unless special anti-static aerials are fitted), the D.I.A.N. system incorporates in one integrated installation both Decca-Dectra and Doppler radar. The significance of such an installation can well be gathered when one considers that the Decca element consists of the non-ambiguous Mk 10 receiver, allied with a Dectra receiver, together with associated computers, control boxes and power supplies, feeding a single Flight Log; and that this same Flight Log is also fed by the Doppler element when in use. Thus a complete hyperbolic aid covering all stages of a long flight from terminal to terminal is available, with complementary information from Doppler, which is independent of ground installations. Thus, on leaving Decca or Dectra coverage the Doppler element is used to maintain the presentation on the Flight Log.

Doppler by itself is not accurate enough to be comparable with Decca or Dectra, since cumulative errors are present; but at the same time, the error factor is not large enough to cause any serious objection. It is not, however, suitable for A.T.C. purposes because, being independent of ground installations, errors are peculiar to each and every installation and are not constant in magnitude or nature. Other valuable facilities provided by the Doppler element of D.I.A.N. are the display of wind velocity (if T.A.S. information is used) together with groundspeed, track, drift and ground miles flown. Two meters display this information, together with position co-ordinates, independently of the Flight Log display. The accuracy of the Doppler element is given as being better than one per cent, assuming no compass error.

The weight of the basic Doppler element is only 69 lb. To this must be added the common pictorial display and its control box, which serve all three elements of D.I.A.N. The Decca element weighs, complete, 101 lb 3 oz, including control box and aerial amplifier. The Dectra section of the installation weighs 33 lb 1½ oz, while to the combined Decca/Dectra elemental total must be added 3 lb 10½ oz for the three Decometers. Thus, the weight for the complete D.I.A.N. installation is 223 lb or less. This is a small penalty to pay for the services provided. D.I.A.N. probably constitutes the most completely acceptable universal navigation system available or projected in the world today. D.I.A.N. with Decca and Doppler weighs only 190 lb.

Comparatively recently developed, and of interest to commercial operators, is the Standard Telephones and Cables, Ltd., SR 32/33 installation, which combines I.L.S., V.O.R. and marker beacon facilities. Such equipment is useful in view of the fact that V.O.R. is being increasingly installed throughout the world as the present I.C.A.O. standard, while I.L.S. is the standard approach system. It is obviously desirable to integrate as far as possible; and I.L.S. and V.O.R. lend themselves to this admirably. Whatever main navaid is carried on the aircraft, a sound "backer-up" is always necessary and V.O.R. may well be the obvious choice, especially since the number of medium wave non-directional beacons in operation is being steadily reduced.

The installation consists of the SR 32, including a combined localizer/V.O.R. receiver, a glide-path receiver and a power unit. Associated with this is the SR 33 marker beacon receiver. The control unit is interconnected with the various receivers in such a way that the appropriate receiver for each frequency is automatically selected. Thus, when a localizer frequency is set up on the control unit, the appropriate glide-path frequency will be selected at the glide-path receiver without any further action. A normal V.O.R. bearing indicator is used, together with an I.L.S. cross-pointer and marker lights. The SR 33 marker receiver is controlled independently, for receiving fan markers on airways or in I.L.S. systems. V.O.R. information can be supplied to a radio magnetic indicator. The total weight of the SR 32/33, including R.M.I. coupling, is just over 100 lb.

A similar recent development is the Marconi AD.704/706/708 developed jointly by the English company and its Australian associate, Amalgamated Wireless (Australasia), Ltd. This installation, at 83.1 lb, has an advantage in weight over the SR 32/33. It provides the same services and, apart from slightly different power consumption and dimensions (again somewhat in favour of Marconi's), there is little to choose between the two.

On the subject of approach and landing, mention must be made of the Standard Telephones and Cables Precision Approach Radar Type SLA.3-B/2. This is the only G.C.A. equipment being commercially produced in the U.K.; and although earlier versions have been adopted by overseas governments, there still exists a curious reluctance on the part of the M.T.C.A. to adopt anything in this line that smacks of development. A new G.C.A. is being installed at London Airport, where it is very much needed, but it is believed to have been designed by the Ministry's own radio branch, and little is known about it.

The Marconi SR.1000 radar self-contained transmitter/receiver and power supply cabinet, shown fully opened for easy direct access.

The SLA.3—B/2 is a simply interpreted and operated P.A.R. system using conventional techniques, with P.P.I. azimuth and elevation presentation on two tubes. The operator is normally stationed in the control tower, and reads directly off both. Elevation information does not have to be passed to him second-hand by the tracker, as in the case of the earlier G.C.A. The two 17-inch cathode ray tubes are mounted one above the other in the same console, the elevation one being uppermost. Alignment of the tubes is such as to bring the range markers into coincidence in the vertical plane. The scan-sectors are ±10 deg in azimuth and from −1 to +6 deg in elevation; and a clear return from aircraft of 15 square metres echo area or larger will be received within these scan sectors at a range of at least nine n.m. from the radar aerials. The performance of the SLA.3—B/2 is at least as good as that required for P.A.R. equipment given in the Third Edition (1.12.52) of *International Standards and Recommended Practices for Aeronautical Telecommunications* (Annexe 10 to the Convention on International Civil Aviation).

Ekco were among the companies showing new equipment at Farnborough, in the shape of their E.160 airborne search radar. Such radar is now considered to be of considerable importance; and the new E.160, which operates in the X-band, has been specified for the latest types of transport aircraft, including the Comet 4, Vanguard and Boeing 707 (Britannias are normally fitted with the earlier E.120). Both these systems incorporate the iso-echo contour facility, by which extreme-turbulence cores within cloud returns can be distinguished from non-critical precipitation returns. Since the pros and cons of the old X- *versus* C-band argument still remain unresolved Ekco have designed a C-band system for those who prefer it.

A.D.F. equipment—used almost universally—has undergone considerable development over the past year. The Marconi AD.7092 series of units is by now more than just well known, being in widespread airline and Service use. A recent Marconi innovation is the AD.712, which has been designed for direct, simple operation by the pilot. It is exceedingly compact and provides for both automatic and manual D/F, range and Consol reception. Tuning is accomplished by selecting the required frequency on a dial like the latest V.H.F. tuning units. Crystal control of the AD.712 ensures accurate tuning with the minimum of manipulation; the loop aerial is non-moving and housed in a near-flush plastic fairing. Another new Marconi A.D.F. is the sub-miniature type AD.722. Again, simplicity of operation is the keynote, and the whole weighs only 24.2 lb including the loop aerial. It is intended for single-seat fighters.

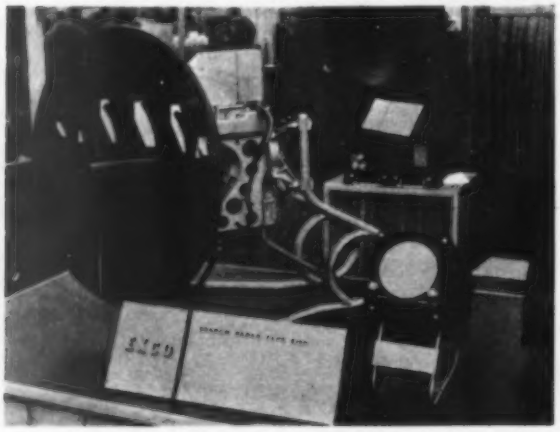
Shown for the first time in public at the S.B.A.C. Show was the Marconi AD.2000 Doppler Navigator (described in *Flight* for July 12). The later AD.2100, intended for mounting in an externally carried pod, was also given its first public view. Details of the civil AD.2300 Doppler navigator were given in *Flight* for June 21 and July 12.

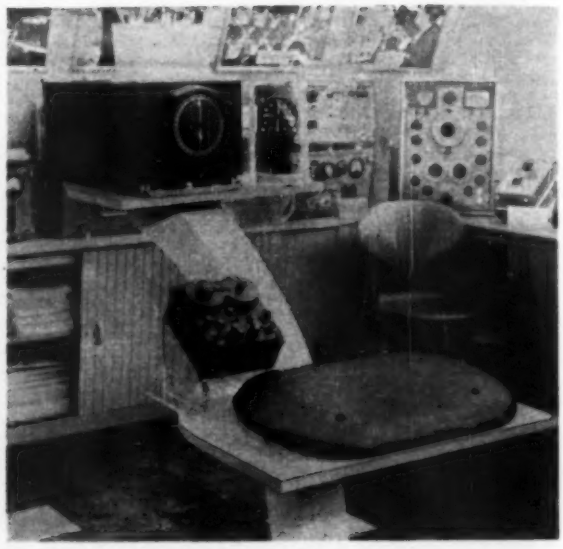
Many new surveillance radars for traffic control have been introduced and developed over the last few years, ranging from the comparatively short range A.C.R. (Airfield Control Radar) to

Right, the Marconi AD.712 Automatic Direction Finder, with its crystal-controlled frequency selector and flat, non-moving aerial assembly.

Below, the scanner and viewing scope of the new Ekco airborne search radar Type E.160, for Comet 4, Vanguard and Boeing 707.

"Flight" photographs





AIR RADIO DEVELOPMENTS . . .

long-range surveillance radar. Special circuits and polarization techniques are now generally incorporated to exclude or palliate unwanted echoes from precipitation and fixed objects, leaving only aircraft echoes. Typical of the A.C.R. function is the Marconi S.232, which incorporates crystal-controlled circuits throughout. Operating in the 50 cm band, the S.232 has an effective range sufficient to handle all types of traffic within the control limits of a major terminal airport; and it can fulfil all airport radar requirements with the exception of G.C.A.

The latest long-range surveillance radar to be produced in the U.K. is the Marconi S.R.1000 high-powered 10 cm equipment. Ease of installation and self-contained arrangement are features of the design of this radar; and it is worthy of note that apart from the display units and aerial head, the complete transmitter/receiver, with its power units, is housed in a single cabinet. All that is required in the way of power supplies is a source of normal A.C. mains supply. The S.R.1000 was shown for the first time at the S.B.A.C. Show this year.

The Cossor secondary surveillance radar shown at Farnborough represents an important approach to the control saturation problem. The value of secondary radar lies in the fact that no reflection of an originated pulse takes place. With ordinary radar the pulse of radio-electrical energy has to travel from the aerial of the transmitter/receiver until it impinges on the reflecting object, and then back again. In the case of secondary radar the initial pulse is used to trigger a transmitter carried in the target, which replies on a different frequency. The effective range of the radar, for a given power, will thus be greatly increased since each pulse only has to travel in one direction.

The Cossor secondary surveillance radar system consists of a ground interrogator operating on 1,215 Mc/s with a receiver frequency of 1,375 Mc/s. The airborne transponder has a transmitter frequency of 1,375 Mc/s and receiver frequency of 1,215 Mc/s. An important feature is that the reply pulses from the transponder can be made to contain a coded reply. The net effect of secondary radar control with this equipment is that only transponder-equipped aircraft will provide echoes; and these echoes will be identified. Thus, if the carriage of the transponder is made a mandatory requirement (its weight is only 30¾ lb), the whole traffic picture will be presented to A.T.C. in a clear and unambiguous form. Many believe that this method of radar control may yet prove to be an answer to the A.T.C. problem.

A significant innovation in the communications field which was shown at Farnborough was the Mullard single-sideband transmitter/receiver Type X.7443. This equipment is designed for pilot operation and has up to 12 crystal-controlled voice channels in the 2.5-20 Mc/s H.F. band. The transmitter has a power of between 200 and 300 W, while the receiver has a good sensitivity characteristic. S.S.B. equipment offers greatly improved characteristics over the normal double sideband equipment.

Development of these and other types of aeronautical radio equipment continues, but it remains to be seen whether they will keep pace with the growing and complex demands of civil operators.

J. H. G.

ELECTRO-THERMAL DEVELOPMENTS

A METHOD of heating surface areas evenly, at temperatures ranging from a few degrees above ambient to approximately 200 deg C, and using a potential from 2 or 3 V up to mains voltage, has been developed by Hunting Percival Aircraft, Ltd. It is called Mhoglas.

During development, it became obvious that metals could not be used, particularly at 240 V, because their resistivity was too low for use as foils or closely woven mesh. Graphite was adopted and glass fabric was chosen as a base on which to deposit a coat of pure graphite in a continuous and perfectly even layer which would avoid fracture or flaking under flexing. Each individual glass-fibre filament is so coated.

Variations in resistance can be effected by changing the number of coatings; and elements are made in resistances from 6 to 100 Ohms per unit square. Most requirements can be made up from standard resistances by incorporating different contacting arrangements. The contacts are normally in the form of sprayed metal; sprayed circuiting and three-phase connecting can be used.

After processing, an element is treated with one of the thermo-hardening resins, generally of the epoxy type. Although the resin coating is the limiting factor for temperature, it does have many advantages, such as ease of "potting" and adaptability for laminating processes and curing with or without pressure, by hot or cold methods. None of these procedures affects the original resistance of the elements. The resistance of Mhoglas elements decreases with increase in temperature, while metals have the opposite effect. These elements may also be designed to operate with a "quick heat-up," a thermostat being used to control temperature.

Among attractive characteristics claimed for Mhoglas are that it is thin, light, flexible and non-metallic; that it is supplied in sheet form and can be shaped, bent and formed, potted, laminated and incorporated in wood, plastic, rubber, concrete or metal; and that it heats evenly to a pre-determined temperature, with no hot spots or tracks. It is made at present in foot-wide strips, usually between three and four feet long; and it can be curved down to a radius of 1in, or, during manufacture, down to a ¼in radius.

UNIQUE CROSS-CHANNEL FLIGHT

A METEOROLOGICAL theory concerning upcurrents over the sea was confirmed in striking fashion by Philip Wills on Sunday, September 15, when, flying his Slingsby Skylark 3 sailplane, he left the Kent coast at 600ft and arrived over the coast of France at 3,000ft. After taking off from Dunstable, his intention had been to carry out offshore soaring between Deal and Dover; but he experienced both a headwind and severe down-currents on attempting to reach Dover when five miles out.

The theory concerns the relative rates of cooling of the land and the sea. During the month of September, it has been suggested, the land cools faster than the sea and hence upcurrents may be expected over the sea. Circling in these upcurrents and drifting downwind, Mr. Wills reached a height of 3,500ft in mid-channel. He landed at St. Omer, about 20 miles south-east of Calais.

Leader of "The Few"

A Biography of Lord Dowding

ONE after another the biographies of great airmen of the Second World War are being written. This one* concerns a comparatively unknown Royal Air Force leader, Air Chief Marshal Lord Dowding. Its publication has touched off a mild campaign to gain for Dowding well-deserved and tangible, though belated, recognition of his supreme services in preparing for and conducting the Battle of Britain. This campaign is gently encouraged in the publisher's note on the dust cover, which says that Dowding "scarcely drew from his achievement the full measure of recognition and acclaim accorded to other successful wartime leaders." Yet in his very thorough investigation into Dowding's conduct and character Mr. Collier found several reasons which seem to support the decision to retire him from the R.A.F. after he had led Fighter Command's victory over the Luftwaffe in 1940. The last chapters of the book describing Dowding's removal conveyed to me a general feeling that his sacking was on the whole quite justified. Dowding was, as Mr. Collier puts it in one passage, "reputedly self opinionated . . . , notoriously difficult to handle, widely if inaccurately identified with a wholeheartedly defensive outlook, reputedly too fond of his own way. . . ."

Whether Dowding was fairly, or unfairly, retired can be argued; and there is much relevant evidence in this biography. It traces in fascinating detail how he foresaw that the future of this country and probably the whole course of the war was to hinge on a great battle to prevent the Germans gaining superiority in the air over Britain. Even today the significance of that battle is not fully appreciated by many people, and this book will certainly help to correct that omission. Dowding prepared for the Battle of Britain from the day in 1936 when he took over Fighter Command; and it was his tremendous strength of character coupled with his experience, first as a soldier and then as an airman, which enabled him to build up his units. It was those same qualities which enabled him to demand, successfully, that his squadrons should not be poured into the losing battle for France—where they would be destroyed, and with them his plans for an effective home air defence. He was bound to be unpopular with some when at a meeting of the War Cabinet on May 15, 1940, he convinced those present that they should not send the fighter help for which the French had asked.

Had Dowding been overruled on that issue there can be no doubt that Fighter Command would have been whittled away, as Dowding himself put it to the Air Ministry, like "opening a tap through which the entire output of those aircraft might be drained away." That was typical of Dowding's sound judgment and planning. Another example was the way he established the best possible relations with Anti-Aircraft Command which, although part of the Army and prone to inter-Service rivalries, was under his direct control.

As a biography, *Leader of the Few* is a comprehensive one. It begins with a brief introduction to Dowding's great-grandfather and grandparents, and progresses through his time at the prep school where his father was headmaster and then at Winchester. Mr. Collier is in no unseemly haste to get on with what we might be excused for calling the more exciting part of his subject's life. It becomes quite clear that the early part of the story is vital, for in it we can see the future C-in-C. of Fighter Command growing up and see, too, how and why he was dubbed "Stuffy" Dowding.

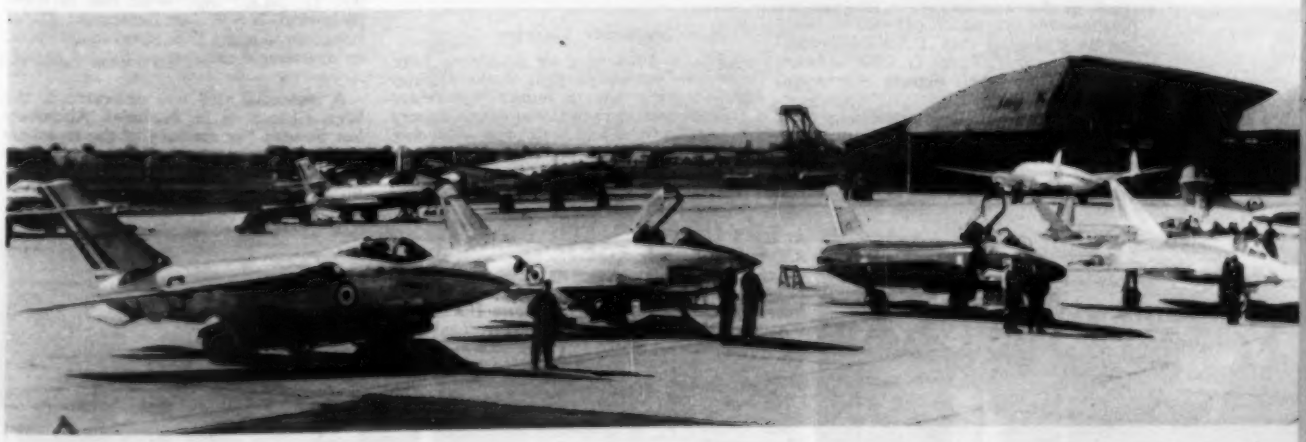
The biography is far more the story of a man who became an airman, than the story of a man's life in the R.A.F. But it can still be classed as a war book, for it contains a wealth of detailed information on the air war in the opening stages of the 1939-1945 conflict. And it is pervaded throughout by the exemplary character of Lord Dowding, who now lives quietly in Kent—over the fields of which the Battle he commanded was won and where he has now turned his abundant energy to the investigation of spiritualism.

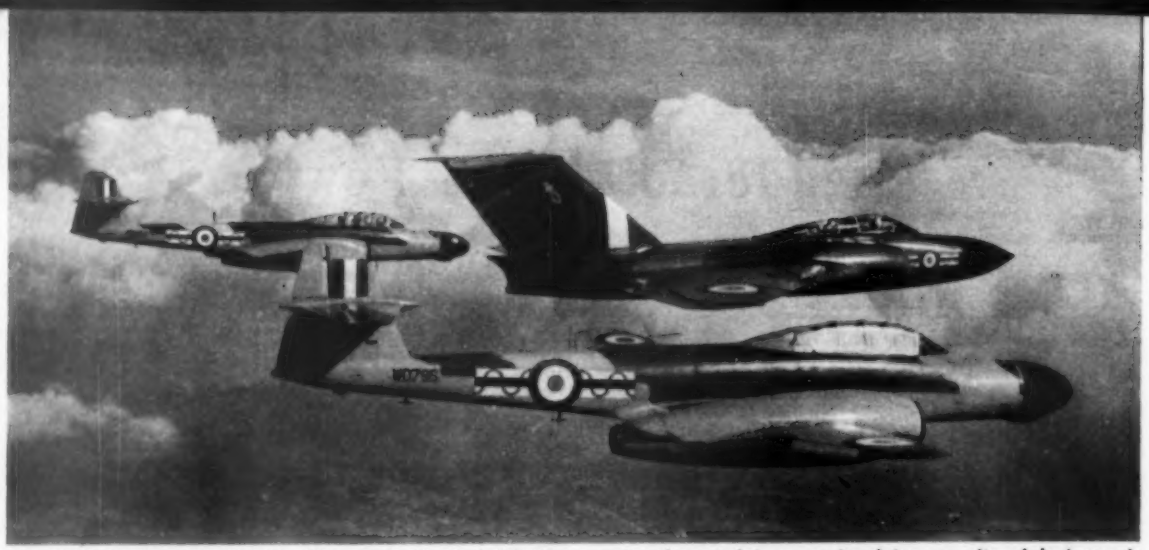
A. C. B.

*"*Leader of the Few,*" by Basil Collier. Jarrolds, 178-202 Great Portland Street, London, W.1. Illustrated. Price 25s.*

THE NATO STRIKE-FIGHTER CONTEST

AS recorded on pp. 500-501, the NATO contest for lightweight strike fighters is now under way at Brétigny, near Paris, where—below—four of the five contestants are seen assembled. Left to right, they are the S.E. Baroudeur (Atar), Fiat G-91 (Orpheus), Bréguet 1001 Taon (Orpheus), and Dassault Etendard VI (Orpheus). Absent from the group is the fifth entry—the Etendard IV (Atar). On the right are the test pilots: (l. to r.) Major Robert D. Hippert, U.S.A.F.; Lt. Cdr. W. R. Hart, R.N.; Major Michele Colagiovanni (Italian A.F.); Capt. Robert Titus, U.S.A.F.; and Lt. Joe F. Lasseter, U.S.N.





One of the Javelins with which No. 87 Sqn.—the first in 2nd T.A.F. to receive them—is being re-equipped (see news-item below) seen in company with two of the squadron's Meteor N.F.11s.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

Standards Laid Up Abroad

FOR the first time in R.A.F. history, squadron standards were laid up on foreign soil when on September 15 those of Nos. 3, 16 and 26 Squadrons—recently disbanded in 2nd T.A.F.—were ceremonially placed in the Headquarters C. of E. church of St. Boniface at Monchen Gladbach, Germany, to remain there "until they are required again."

This laying-up ceremony took place during a Battle of Britain Sunday service attended by the British Ambassador to Bonn (Sir Christopher Steel), the C-in-C. British Army of the Rhine (General Sir Dudley Ward), the C-in-C. 2nd T.A.F. (Air Marshal Sir Humphrey Edwardes Jones), and A.O.C.s and senior staff officers of Nos. 2 and 83 Groups.

Air Marshal Edwardes Jones, as C-in-C. of the Command in which the squadrons had last served, committed their standards into the safe keeping of St. Boniface Church, and they were received by the R.A.F. Assistant Chaplain-in-Chief, the Rev. G. Hyslop, who conducted the service.

Javelin Conversion Unit

AT Bruggen in Germany the latest R.A.F. squadron (and the first overseas) to be re-equipped with Gloster Javelins—No. 87, which is based at Bruggen as a unit of 2nd T.A.F. and commanded by W/C. L. W. G. Gill—is being converted by the Fighter Command Javelin conversion unit.

This mobile unit—commanded by S/L. P. D. C. Street and based at Leeming—grew up almost as part of No. 46 Squadron, the first to receive the Javelin and last year re-equipped with Mk Is.

The unit has two Javelin pilots, four navigators, two Valetta pilots for its "flying radar classrooms," and 16 ground crew. Technical lectures are given by a representative of the Gloster Aircraft Co.

All squadron personnel first have to attend technical and handling lectures, and then split up into various training groups. Pilots have three periods in the conversion trainer, a simplified form of simulator in which cockpit drill and emergency procedures—in fact, any conditions other than those concerned with flying controls—can be reproduced.

First flying experience is gained in the navigator's seat of the Javelin, and it is said that when ex-Meteor pilots have their initial experience they do not find handling characteristics very different except for the powered controls. Thereafter new Javelin pilots have to carry out six day-trips (covering all aspects of training), and one night familiarization flight, before being considered operational. Navigators, receiving their radar training in the Valettas, the lecture-room and the caravan radar classroom, must do 13 sorties in the Javelin on A.I. training before being considered operational.

All the conversions the unit has so far carried out have taken place without incident—a remarkable safety record.

U.A.S. Summer Camps

ALL 17 university air squadrons have now completed their summer camp training, the last to finish—Manchester U.A.S.—ending their sojourn at Shawbury (where Glasgow had been previously) only a week ago. Some of the squadrons travelled long distances. Edinburgh, for example, went to St. Mawgan in Cornwall, Aberdeen to Hemswell and Durham to St. Athan in S. Wales.

With just over 800 cadets in camp, an estimate total of 15,000 hours' flying has been achieved. This is some 2,000 hr down on last year, largely because many training periods occurred in July when the weather was bad. Cambridge U.A.S. flew 2,600 hr in six weeks—between June 21 and August 2—a record for any squadron. There were no injuries or major accidents at any of the camps; and apart from their own aircraft, cadets gained flying experience in Shackletons, Meteors and helicopters.

No. 825 R.N.A.S. Reunion

A REUNION dinner for past and present members of No. 825 R.N. Air Squadron is being held tomorrow at the R.N.V.R. Club, 38 Hill Street, London, W.1, at 7 p.m.

IN BRIEF

Air Commandant Mary Barnett, Director of the W.R.A.F., is flying to Germany on October 1 for a ten-day visit to units in 2nd T.A.F. where W.R.A.F. are serving.

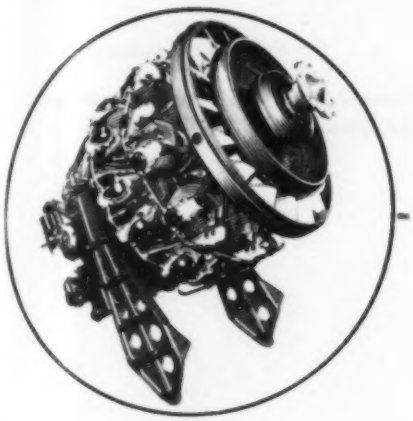
* * * * *

Two R.A.A.F. P2V-5 Neptunes of No. 11 (M.R.) Sqn. were due to leave Richmond, N.S.W., on September 21 for Honolulu to join a U.S. naval squadron on an operational exercise.

* * * * *

A memorial stall was dedicated in the West Church of St. Nicholas, Aberdeen, last Sunday "in memory of the members of No. 612 (County of Aberdeen) Squadron, R.Aux.A.F., who gave their lives during and after the Second World War."

At U.A.S. summer camps (referred to above), A.V-M. H. V. Satterly, A.O.C. No. 64 (Northern) Group, talks to Glasgow cadets at Shawbury; below, a Cambridge U.A.S. Chipmunk airborne from South Cerney; and right, Manchester U.A.S. practising formation from Shawbury.



7 people by helicopter to 11,600 ft. —powered by the Alvis Leonides Major

During a mountain rescue demonstration to the Austrian Army recently, a Westland Whirlwind helicopter with an Alvis Leonides Major engine flew five passengers and two crew to the top of an 11,600ft (3.540m) mountain peak. The helicopter hovered over the peak, landed just below it, then took off and returned to base. Although not an altitude record in the official sense, this is believed to be the first time 7 people have been carried vertically to over 11,000 feet in a helicopter—a significant demonstration of helicopter performance with the Alvis Leonides Major engine.

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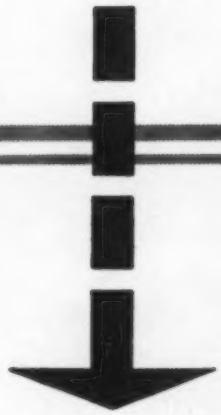

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The Folkestone Conference

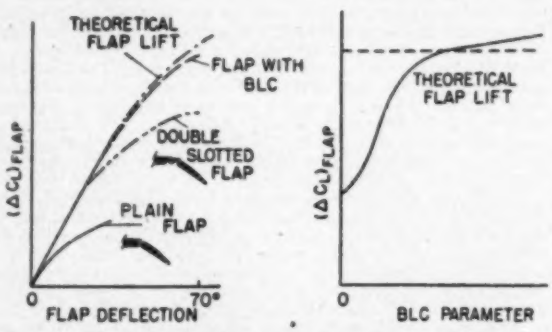
Final Two Days of the R.Ae.S.-I.A.S. Meeting

LAST week, on pages 473-476, we summarized the discussions of the first eight lectures read at the Sixth Anglo-American Aeronautical Conference at Folkestone. The final lecture of the series—now, traditionally, the Wilbur Wright Memorial lecture—was also reported (on p. 477). Here we review the proceedings of the remaining eight technical sessions, held on September 11 and 12.

THE considerable topical interest of **Charles W. Harper's** paper on *Increased Usable Lift Through Boundary Layer Control* was emphasized by the number of delegates present for this lecture on the third day of the conference, Wednesday, September 11. Mr. Harper is an aeronautical research scientist at the N.A.C.A. Ames Aeronautical Laboratory, California. Some of the main points of his paper are summarized below.

Studies by the N.A.C.A. on the use of boundary layer control to increase lift have become much more intensive in the last five years. Effort has been directed at devising means of applying boundary layer control which are compatible with other requirements of aeroplane design. The changes in aircraft brought about by designing them for higher speeds have eliminated, successively, almost every feature favourable to low-speed flight, so that the need for better low-speed characteristics is great.

The characteristic of B.L.C. of primary interest here is its



Typical relative flap lift values for various flap arrangements and at various angles of attack.

effect on lift. The result of applying it to a flap is best shown through the variation of flap lift increment with flap deflection and with the B.L.C. parameter appropriate to the form used, that is, flow quantity for suction B.L.C. or jet momentum for blowing B.L.C. On the left above are illustrated typical relative lift values for several flap arrangements and for a theory based on inviscid flow conditions. It can be seen that a plain flap has begun to fall short of its potential lift at about 15 deg deflection and the double-slotted flap at about 30 deg deflection, whereas with B.L.C. the potential theoretical lift has been shown to be realized up to 70 deg deflection. The typical variation of flap lift with B.L.C. parameter is shown on the right; it has been found many times that a B.L.C. flap has this characteristic of a rapid rise in lift only up to the potential value. A major part of the research work has been to reduce the amount of boundary control required to reach the potential lift value of a flap.

The effect on lift of applying B.L.C. to a wing leading edge is to enable a near-linear extension of the lift curve to higher angles of attack. We have not found an upper limit to B.L.C. effectiveness in increasing the angle for stall: in every instance studied so far, the limiting angle of attack was imposed by B.L.C. power requirements, excessive induced drag, inadequate trimming power, unacceptably high attitudes or, perhaps most important, deterioration of stability.

It remains to determine how to apply B.L.C. to increase lift. The basic problem is one of overcoming the instability of boundary layer flow in regions of increasing pressure which exist at high lift. Two solutions to the problem are to draw away through the surface the low-energy air which is associated with incipient separation, and to re-energize this low-energy air by a high velocity jet.

In considering the application of either B.L.C. system to a flap, a decision must be made as to the type of flap best suited. Ames' research work up to the present time shows that either plain or slotted types can be made fully effective with about the same amounts of B.L.C. When the structural simplicity of the plain flap is also taken into account, it appears to have a definite advantage over the complicated single- or double-slotted flap.

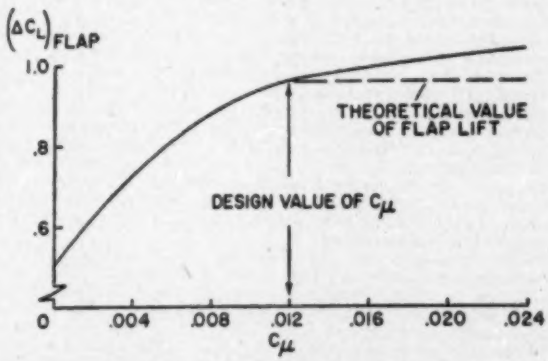
The application of suction B.L.C. to a trailing edge flap has been guided by the analysis made by Thwaites, which was directed at controlling air flow separation from the wing leading edge. The important conclusion was that area suction, properly placed, would reduce the suction flow quantities required to very low, and therefore practical, values. Attempts to extend this analysis to the case of trailing edge flaps have failed so far, except in a qualitative sense.

The extent of porous area through which suction has to be applied extends from the minimum pressure point to the chordwise station, where the pressure on the highly deflected flap has increased to the value of the lowest pressure measured on the flap without B.L.C. and without separation. It is reasoned, and has been experimentally verified, that full pressure recovery can be realized between this point and the trailing edge with no further use of B.L.C.

The duct pressure required, of course, is directly dependent upon the minimum external pressure and the pressure loss from drawing the air through the surface at the required velocity.

The total quantity of air flow is of prime importance in judging the practicality of a B.L.C. installation. An inflow velocity of about three per cent of the free-stream velocity is required at the point of minimum external pressure. Control of the inflow velocity distribution is obviously important in holding the total quantity within practical bounds. Following the analysis of Thwaites, porous surfaces have been designed to maintain constant inflow velocity aft of the point of minimum external pressure, and it was found that flow separation was prevented. Experiments have also been made which show that at some points the inflow velocity can be reduced below the three per cent value while still maintaining full B.L.C. It is evident that a possibility of reducing further the air flow requirements is of interest and it should be the subject of further research.

The development of the application of blowing B.L.C. to trailing edge flaps has been based almost entirely on experimental work. Within the limits of Ames' work, it has been found that the highest lift for a given jet momentum is realized with the jet nozzle placed at, or just forward of, the point of minimum



Experimental variation between flap lift and jet momentum for an F-86 Sabre aircraft (60 deg flap at 120 kt).

pressure on a plain flap. In addition to relating the lift to the jet momentum for a given flap geometry, it has also been found possible to relate the blowing B.L.C. requirements for wings of different sweep (and having a plain flap) when the value of jet momentum is based on the component normal to the flap hinge line of the free stream velocity.

It is clear that the most likely application of blowing B.L.C. will occur in the turbojet-powered aeroplane where a limited source of high-pressure air exists in the compressor.

Turning to the problem of applying B.L.C. to a wing leading edge, our experience has produced some interesting results which may be of value in guiding research on the problem. Two major

THE FOLKESTONE CONFERENCE . . .

questions arise. First, what are the B.L.C. requirements to realize a desired increase in maximum lift; and second, what increment in maximum lift can be attained while still retaining acceptable stalling characteristics? Some progress has been made in coping with the first problem, but the solution to the second remains largely an art and not a science.

The application of blowing B.L.C. rather than area suction B.L.C. to a leading edge or leading edge flap is still in the preliminary study stage, but looks exceedingly promising for some applications; research has progressed sufficiently far to demonstrate that this type of B.L.C. is more powerful than area suction B.L.C. Our experience indicates that, as for the area suction B.L.C., the greatest effectiveness will be obtained in conjunction with a leading edge flap. Two-dimensional results again appear to be a useful guide in three-dimensional designs.

The fact that a practical B.L.C. system can increase aeroplane lift is of little interest unless an improvement in landing and take-off performance is also realized. From analyses, it appears that every design will show a reduction in landing and take-off distance with the use of B.L.C., provided that consideration is given to its use *from inception of the design.*

Realizing that wind tunnel work alone could not demonstrate the practicality of B.L.C. to obtain increased usable lifts, Ames has modified and flight tested a series of F-86 aeroplanes incorporating different forms of B.L.C. Sintered stainless steel was used on one aircraft as the fixed porous surface which replaced the production slotted leading edge. Lacking a pump designed specifically for the job, a turbo-supercharger was modified to be driven by bleed air from the J-47 turbojet compressor. The lack of a proper pump has proved a major barrier.

Area suction was also applied to the trailing edge flaps of a second F-86. The standard slotted flaps were rebuilt to the form of a plain flap with a porous surface, and hinge line on the lower surface, and the flap deflection was increased. A third F-86 had its flaps modified to incorporate blowing-type B.L.C.

Realization of the first flight objective, comparison of the characteristics determined in flight with full-scale wind tunnel tests of the various F-86 aeroplanes, showed that the wind tunnel correctly predicted these characteristics.

Operational experience was a second objective of the flight tests. No special care has been necessary for the area suction systems. At no time during some two years of research operation was it necessary to clean or replace the porous materials. In one instance the aeroplane with leading edge area suction was flown into and out of a rainstorm at an angle of attack above that for which maximum lift would be exceeded without the area suction B.L.C. in operation; the pilot found no loss of lift, or any other indication that the B.L.C. had lost effectiveness.

Pilots' reactions to the use of the B.L.C., the third objective of the flight tests, form probably the most interesting aspect of the flight programme. In particular, it was desired to obtain from the pilots an opinion regarding the effect of B.L.C. on the stalling characteristics of the aeroplanes, and a measure of the change in minimum comfortable landing approach speed resulting from the use of B.L.C. It would appear that the use of B.L.C. tends to reduce the stall warning below an acceptable value. But this was compensated for in part by an improvement in lateral-directional control and stability near the stall which was described by the pilots as a "more solid feeling." The flight studies, made to determine whether the B.L.C. would result in a reduction of the pilots' chosen approach speed, showed that in every instance it did. Thus, in a qualitative sense at least, the wind tunnel results and the performance analysis based on these results were satisfactorily substantiated.

The discussion was opened by Dr. W. F. Hilton (A.W.A.), who commented that the lack of stall warning with B.L.C. had occurred on other aircraft; he suggested that this disadvantage could be overcome with a stickshaker. He queried the effect on an aircraft making use of B.L.C. should an engine fail. Dr. J. Williams of the R.A.E. advocated B.L.C. at the aerofoil nose to make sure that the full effects of flap blowing were realized. But, he said, there were both aerodynamic and structural difficulties in blowing at one or two per cent of the chord; the jet could not always be persuaded to follow the curved surfaces.

Dr. G. V. Lachmann of Handley Page, commenting upon the lecture, said that no clogging of porous surfaces in two years was a good thing, and disposed of an old red herring. He emphasized that control was very important when an aircraft is flown below the minimum drag speed.

This theme was expanded by Mr. R. R. Duddy (R.A.E., Bedford), who talked of the effects on approach speed of flying "on the backside of the drag curve." Instability occurs, he said, only if the pilot is trying to fly along a prescribed path such as governed by I.L.S. or a deck landing mirror. Pilots always use elevator for small and rapid changes of height; this had been noticed by the R.A.E. when pilots were forced to use elevator because jet engine response was poor. The solution was an automatic throttle-control, of the type that was used by R.A.E. on approaches below the minimum drag speed. A final point was that pilots had complained of an unwanted coupling between lift and thrust with B.L.C.; height could not be lost without gaining unwanted speed.

Other delegates discussed the relative advantages of "suck or blow." Mr. N. E. Rowe (Blackburn) suggested that the engineering required for blowing is simpler, and Mr. A. C. Lovesey (Rolls-Royce) remarked that the by-pass engine offered a better solution for providing the suck or blow than compressor bleed.

Sir George Edwards subsequently returned the discussion from academic to practical levels by reminding his audience there were aircraft in full production—and others nearly in production—with blown flaps.

Under the chairmanship of Dr. T. P. Wright, a lecture on *Safety in Relation to Structural Damage*, given by **Dr. A. E. Russell**, stimulated discussion on the controversial structural subject of previous conferences: "fail safe" or "safe-life."

Mr. W. Littlewood (American Airlines) said that too much of the safe-life philosophy was a bad thing: "Should aircraft be sold at different prices," he asked, "because they operate under different conditions at different aircraft lives?" We operate over mountains, while others operate over the sea. Referring to a point in the lecture, he said that several American airlines kept an intimate history of fatigue cracks, a point which troubled Mr. E. D. Keen (A.W.A.), who asked for information on the rate of propagation of cracks in relation to the time of application of the load and if there was evidence of stress corrosion at the ends.

Several delegates, among them Mr. Tye (A.R.B.) and Dr. P. V. Walker (R.A.E.) agreed that, to some extent, the fail safe concept had to be accepted if design was to be realistic—fatigue was "still the greatest structural hazard of aviation." Another important point raised was whether full-scale water tank testing was still required, although Dr. Walker suggested that destroying an aircraft was justified to find cracks and to show airframe inspectors where to look for them.

Dr. Russell replied that he thought it most unlikely that there would be a further need for full scale water tank testing, except for the cockpit and other difficult areas; better results could be obtained by an increased number of detail tests and extensive strain gauging of the complete airframe. He concluded with the significant observation that there must be ample cross-checking in design offices to ensure previous mistakes were eliminated.

The remaining lectures read on September 11 were *An Appraisal of Aeroelasticity in Design, with Special Reference to Dynamic Aeroelastic Stability*, presented by **Martin Goland** of the Southwest Research Institute, Texas; and *The Presentation of Information by Aircraft Instruments* by **A. Stratton** of the R.A.E.

Discussions on the earlier paper centred on the safety aspects of flight flutter testing when the "hard" mode of flutter was anticipated. Mr. Goland had ruled out the possibility of doing such tests, but Mr. M. O. W. Wolfe (R.A.E.) and Mr. J. C. A. Baldock (Handley Page) disagreed, particularly if the aircraft was fully instrumented. Suggestions were put forward that flutter testing should be done with the aircraft artificially stabilized, but other speakers suggested that the aircraft should be artificially de-stabilized so that the stability margin could be progressively reduced until flutter was found.

Mr. Stratton's paper was discussed at length. Capt. Majendie (Smiths Aircraft Instruments) noted that the lecturer had dealt with high performance aircraft; there was likely to be a parting of the ways where transport aircraft were concerned. Mr. Carl L. Frederick (Frederick Research Corp.) queried the type of lighting to be used, and other speakers—notably Mr. H. C. Pritchard (Elliott Bros.)—asked about the provision of collision warning devices. Mr. J. Lederer (of the Flight Safety Foundation) said that flying had changed "from the seat of the pants to the back of the head." Audible as well as visual sources of information should be used; pilots should have to interpret rather than read. There were 40 airline pilots over 60 years old in the U.S.A.; they wore not bifocals but trifocals—we should design for them. And, he added, every knob represents an error.

Replying, Mr. Stratton agreed that knobs should be worked by an automatic system. Infra-red lighting would be used for presentation and (in reply to another question) he said there was a case for presenting some data on the windscreen panel.

Among the papers read on the final day of the technical session was one by **A. Harvey-Bailey** on *Design for Repairability of Civil Turbine Engines*. The following extracts underline the results of his experience with Rolls-Royce turbines.

The civil turbine engine must have three important attributes which can all be influenced by design for repairability: engine reliability, long life between overhauls, and an economic usage of parts at overhaul. It is important that parts should be replaced in as small units as possible, so that parts cost at overhaul can be kept to a minimum.

The turbine disc represents a specially interesting problem since the need for establishing its integrity at overhaul is fundamental. Cooled ferritic turbine discs had paid a dividend from

the repair aspect, because the material used has been found to respond excellently to standard crack detection.

Long experience has shown that in the centrifugal engine it is the leading edge of the guide vane which is liable to be damaged and eroded. The ability to replace the rotating guide vane can effectively extend main impeller life in the event of damage due to foreign objects.

Multi-stage axial compressors bring complication. Each individual blade of the Avon is fitted to the compressor disc by a pin fixing, which has a comparatively slack clearance. In the large blades in the low pressure stages the pin holes are bushes, and by quite simple repair tooling it is possible in the event of pin hole deterioration in either blade or disc to fit a new bush in the blade, or a thin steel bush in the disc. This has the advantage that it allows a standard size of pin to be used, and obviates the use of pins of varying size in any given stage.

In many rotating structural components where absolute rigidity is required, taper bolts are used extensively. In the past, taper bolts have always been regarded by the repair engineer with considerable suspicion. However, the need to maintain freedom from relative movement between adjacent components has led to considerable development work. It has been found that the rate of replacement is negligible, the difficulty of mating parts is vastly improved by the elimination of fretting, and their ultimate life thus extended.

Common to both straight jet engines and propeller turbine types are flame tubes; the first standard of Dart tube required a major repair by replacing the front cylindrical section at about 600 hours. A modified design has been operated satisfactorily to 2,500 hours without repair at overhaul, and the majority of tubes only require inspection. Tubes with riveted cooling rings in sec-

Dart flame tubes showing the replacement components of the later riveted type. An earlier tube is on the extreme right.

tions allow new rings to be fitted without structural dismantling of the tube and re-welding; individual sections showing deterioration may be removed complete and a new section fitted.

On first sight the Dart layshaft is not an easily repairable item because the roller bearing tracks—which would be rejected for small defects—are integral with the shaft. Although a tremendous amount of design and development effort went into detachable races, it was found that the problems were almost insurmountable; the detachable race tended to creep under the heavy kneading loads of the rollers, and wear and tear occurred not only on the locating diameters, but on the end faces carrying the load of the retaining nut. The virtues of integral bearing tracks of this nature are so clear that no one would now consider attempting to develop detachable races for such an application.

It is important that engines should have a certain amount of margin designed in, so that there can be a slight drop in efficiency without affecting the rating and acceptance powers of the engine; for if the margin is not provided in the initial design, it will lead to a heavy replacement of parts at overhaul.

It has been found in the long run easier to remove an engine to renew components at part life than to attempt to design-in ease of replacement of main units, because it has been shown that a penalty of unreliability may be entailed. Further, it has been demonstrated that the influence of vibration from a defect in a main rotating component can be widespread.

The aim should be to design for repairability without prejudicing the targets of long life and high standard of reliability. It cannot be expected that overhaul and repairability will become simpler, particularly as operating experience has demonstrated beyond all doubt that reliability is probably more important than actual ease of overhaul and repair.

Commenting upon this paper, Mr. C. Froesh (Eastern Airlines) said that he wanted it to be possible for overhaul costs to be estimated and extrapolated for gas turbines. He looked for lower turbine temperatures, lower specific consumption and lower exhaust velocity for civil turbines. It was airline philosophy to weigh-up mechanical stress and financial stress; the most successful aircraft had the lowest costs per ton mile. Mr. F. M. Owner (formerly de Havilland) agreed that long life rather than easy replacement should be the aim, but interchangeability was valuable both for individual components and whole assemblies; integral one-piece fuel systems, etc., were a good idea. He propounded the use of used parts to find the *remaining* fatigue life of components.

Mr. R. C. Morgan (B.E.A.) said that 14 per cent of direct operating costs went on engine overhaul. It used to be five, and turbines are four per cent more expensive than pistons. If engine life turned out to be 200 hr less than expected, D.O.C.s rose by 2.5 per cent.

Deflecting devices for turbine wheels were advocated by Mr. W. Littlewood (American Airlines), who also made a plea for the sectional removal of engine components; common overhaul times were impractical. Engines should be seperable, removable and accessible.

In his reply, Mr. Harvey-Bailey said that vibration indication would be a good thing to have. Rolls-Royce were sensing cooling air outlet temperature as an indication of engine condition.

Introducing **H. H. Kurzweg's** paper on *The Role of Experimental Hyperballistics in the Development of Future Aeroplanes and Missiles*, the chairman, Dr. G. W. H. Gardner, said that this startling and stimulating paper came as a breath of fresh air on a closed subject—an opinion which was borne out by the many congratulations the lecturer received. Mr. H. H. Gardner (Vickers-Armstrongs) remarked how rapidly aeronautical conferences are approaching the interplanetary sphere and that the lecturer had shown openings for the "bright young physicist" in aeronautical engineering. But, he warned, we are up against an economic parameter; we have got to decide what we are doing and how we shall end up.

Dr. von Kármán, whose comments were warmly greeted by the assembly, said that the only problem of reaching the high Mach numbers achieved by missiles was one of temperature, not speed; although acceleration would have to be considered. The wind tunnel was not "dead" at Mach 6; good agreement had been found in calculation of conditions behind the shock waves and this information could be extended up to Mach 16.

Mr. L. F. Nicholson (R.A.E.) compared model testing at various speeds. Usually, he said, we get the Mach number right and the Reynolds number as high as we can go, although it varies as we increase Mach number. In hypersonics, M varies, and we must get the temperatures right. It is also very important to understand the fundamentals. A need is for a hypersonic aerodynamic tool with a really long running time—at least a few tenths of a second. These blow torches [hypersonic shock tunnels] must be turned into wind tunnels. Mr. Nicholson also gave a warning that the determination of actual measurements and deduced assumptions must be carefully watched.

Suitable facilities for hypersonic testing were also discussed by Dr. Franklin Moore (Cornell Aeronautical Laboratory). The gun tunnel, he said, was remarkable and probably the best service available in this field; the shock tunnel was a wind tunnel in itself. One advantage of a fixed model is that you can telemeter it and you can get ten sets of information from it. In reply to the previous speaker, he said that the testing time of a shock tunnel can be extended from a millisec to ten millisecs. Referring to the doubts expressed by a previous speaker on the use of hydrogen in a gas tunnel, Dr. Moore suggested that at 50,000 to 100,000 lb/sq in, any gas becomes a pressure bomb and the question of a combustible gas is not so serious.

In his reply, Dr. Kurzweg said that he hoped he had not been misunderstood about hypersonic aircraft. It was "just a question of time," flying high, and designing for heat transfer rates before hypersonic aircraft designs were achieved. We had opportunities of full scale testing, and we should not forget fundamental investigation.

The first afternoon lecture on the last day of the technical sessions was given by **Franklin K. Moore** of Cornell Aeronautical Laboratory, New York. Introducing the lecturer, the chairman, Mr. R. O. Jones, reminded the session that Dr. Moore was the editor of Volume 4, *High-speed Aerodynamics and Jet Propulsion*, of the Princeton series. His paper, *Aerodynamic Effects of Boundary Layer Unsteadiness*, came in the category of what Sir George Edwards later described as a "catalyst" for discussion, and the references in the work to the effect of unsteady boundary layer conditions in damping or amplifying certain instabilities—such as flutter of panels and stalling flutter of aerofoils—were amplified in the discussion. This was one of the more specialized papers in the conference and attracted considerable interest from researchers in parallel fields, Mr. W. P. Jones (N.P.L.) bringing along a film showing an aerofoil with a hinged flap moving at various rates under a range of boundary layer conditions. The lecturer would not be drawn when asked to formulate conclusions from what he had seen, but both lecturer and questioners agreed that more information was required on such phenomena as aileron buzz. All that was known about it was that it is

THE FOLKESTONE CONFERENCE . . .

associated with shock effects on the boundary layer.

The final lecture of the sessions, chaired by Mr. Jerome Lederer, was chosen for its universal and topical interest and was given by a doctor—not of science, as many previous lecturers had been, but of medicine. *The Human Pilot as an Aircraft Operator*, subject of the paper by **S/L. T. C. D. Whiteside** of the R.A.F. Institute of Aviation Medicine, was also notable for the manner in which it was delivered: for S/L. Whiteside ignored his written words in favour of a verbal (and amusing) appraisal of what he referred to as "Man v. Black Box." Some extracts from his written paper are summarized below.

The advantages of man and machine are complementary, the deficiencies of one being compensated by the capabilities of the other; so it is clear that if the physical environment in which the task has to be done is tolerable by man and by machine, the optimum performance will be achieved by an alliance of the two. It must be, however, an alliance in which the capabilities of the machine are realized and in which the task presented to the man is one which calls for, and makes use of, those qualities which are peculiar to him: determination, judgement and the integration of information. Man's qualities are defined for us by millions of years of development. Since he cannot be designed around the machine, the machine he works with must be designed around him, always remembering his capabilities and the limitations of both systems. This is no easy task, for it demands close co-operation between engineers and biologists and in this association the first stumbling block is usually in the engineer's first question regarding the human operator: What are the tolerance limits? How fast can he act? What *g* forces can he tolerate? What weight can he tolerate on his head? What noise levels can he tolerate? What are these levels? Plus or minus what?

The difficulty is that we talk different languages. The engineer's science is a precise one (or at least one of precise numbers), whereas the biologist has to deal with living matter which is never in an absolutely predictable state. A man's height and weight are incapable of being measured to the accuracy the engineer would require of a metallic structure. The engineer, too, has this difficulty; but a definition of temperature and of pressure usually suffices to make his calculations precise. The factors affecting man, however, are too numerous and the interactions too complicated to make precise measurement possible—and if, by profound understanding of the factors involved, it *were* possible, the results could be rendered useless if the subject felt too tired to stand up straight.

In the presentation of information, whether it be to the airborne aircraft operator, or to a man on the ground, there are three principal aims. First, the presentation must be assimilated as quickly as possible; secondly, the information presented must relieve the pilot of fatiguing tasks; thirdly, the presentation should be designed to avoid misinterpretation. Numerical data should be avoided and a graphical presentation favoured.

It is now accepted that the sense in which a pointer indicates change of attitude should be "natural"; that is, it should be displaced towards the direction of movement of the aircraft and should be centralized by an opposite movement of the controls. But as regards the displacement of all positions which can be centralized by a movement of the control column, it is unwise to generalize. To correct a moving pointer by an opposite movement pre-supposes that the operator identified himself and his aircraft as stationary in space, but, if he is being subjected to marked angular accelerations, the labyrinth and the eyes will give strong sensations of turning, so that a tired pilot with limited experience may attribute the movement to the aircraft and instrument, and may thus feel that the pointer is stationary in space.

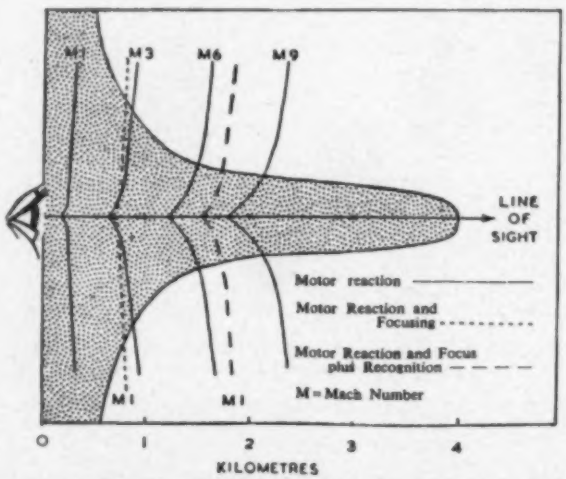
Concluding his paper, the lecturer asked: Should one consider having a human aircraft operator? To do so obviously brings up many problems, the first being how best the man can be incorporated into the machine. The advantages are flexibility of programming, possible weight saving, and simplification of design, of construction, and of maintenance. The examples of man's failure show that he is by no means as capable an individual in the air as he is on the ground. Undoubtedly the performance of some tasks, such as mental arithmetic, can be impaired by physical stress; but the significant observation is that the mental impairment can be overcome by training. But physical impairment, being of reflex origin, cannot. It is therefore such tasks of conventional piloting which could with advantage be taken over by a "black box." This calls for some simplified form of control so that the operator may be able to select height, speed and course, or to take over manual control should the machine fail. And so it seems that the rôle of the aircraft operator of the future will be rather that of monitor, with responsibility for programming the machine in flight according to his assessment of the situation. Such a rôle, if anything, increases the importance of instrumentation and the presentation of information. In this connection, man must not be treated as a digital computer, and constant use should be made of his ability to integrate information and to assess situations. While a machine can carry out motor tasks more efficiently than a man, a great weight penalty would have to be paid to produce a machine which could distinguish such small stimuli as can be detected by the human eye. Furthermore, there is the distinction to be drawn between the perception of a stimulus by the man, and the mere recording of a stimulus by a machine.

Such is the problem. It seems in conclusion that the answer to the question "man or no man?" depends on the answer to the question "flexibility or no flexibility?"

The first delegate to comment on this paper was A.V-M. G. S. Roberts (R.A.F. Bomber Command), who remarked that it was his experience that the main weakness of man as an operator was a predisposition to disorientation. He also discussed at some length oculargravic phenomena—the peculiarity of vision that had caused crashes on take-off which were inexplicable until the cause had been found. It was due to acceleration effects along the line of flight. Drawing further on his experience, he referred to the difficulty pilots always had in coping with too many motor tasks. The Spitfire with a six-bladed propeller (and no torque effect) had cured previous complaints of longitudinal instability. He thought that instrument flying required to be black box flying and should be reliable enough to permit a monitoring and programme-altering function only.

Reaction times of machines and man were compared by Mr. C. D. Holland (Handley Page), who also asked the lecturer how stationary a pilot could hold his controls; he was interested in the fatigue case of powered flying controls where fluctuating pressures occurred even when the pilot's control column was held nominally stationary.

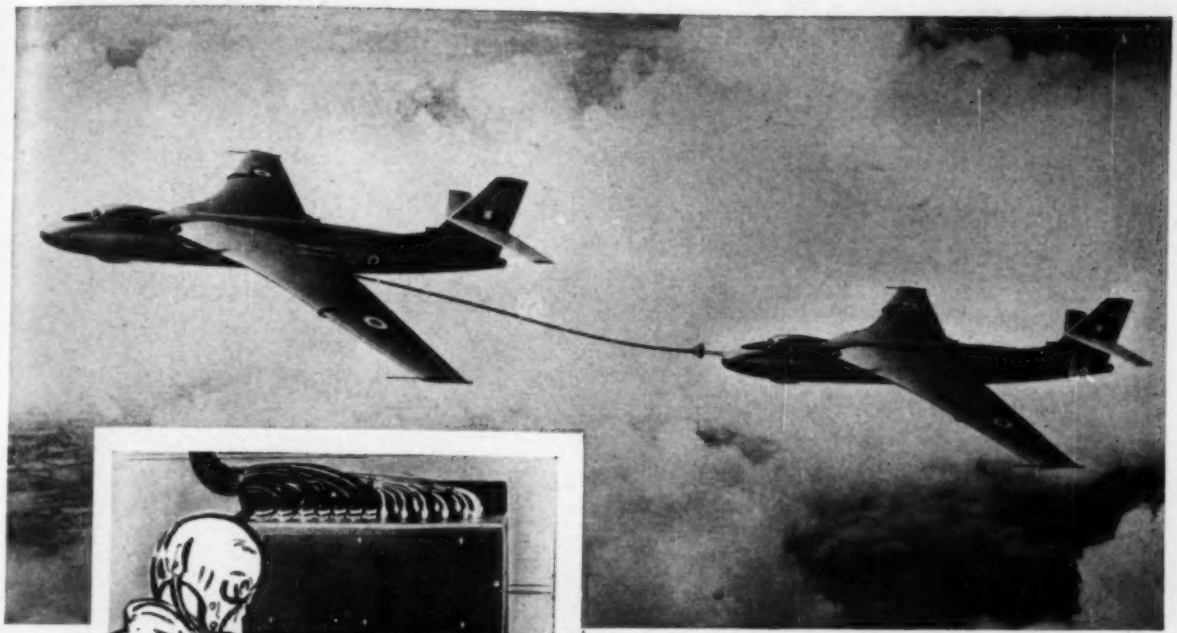
Mr. J. M. Nicholson (chief test pilot, de Havilland Engines),

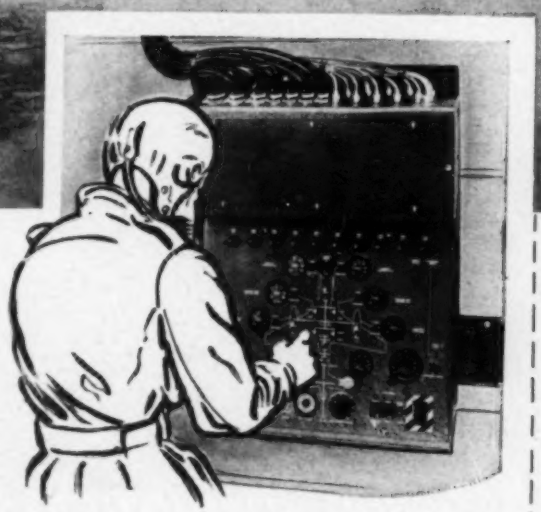


Restriction of the visual field at a range of high speeds. The limits of visual acuity are shown by the shaded area of the graph.

said it was hard for a pilot to be objective about this question, but the point was not whether but *where* man should be included in a system, since man is capable of re-planning information as it becomes available. Another pilot, Mr. H. N. D. Bailey (Rolls-Royce) could not agree that high speed flight shortened the effective time scale. It was, he said, a question of rejection of unnecessary stimuli; and he gave as an example the replacement of small-scale maps by the 1/500,000 map now in general use. Mr. Bailey also advocated the use of some form of artificial stimuli at very high altitudes where visual references were few and the horizon was appreciably below the line of sight. Turning to transport aircraft, he queried the ethics of control by a black box, and suggested that if there was no man in charge some lack of responsibility would result.

The final speaker, Mr. S. Scott-Hall (Air Ministry) suggested that black boxes have it all their own way when the human factors of acceleration and speed of reaction time are considered. Have we really done all we can to improve human performance? he asked. The time for doing so will soon be past. Judgement and singleness of purpose are the most important factors the human operator can contribute. Little work seemed to have been done on the study of emotion—for instance, comparing the reaction to fear of a lion and a rabbit; and he suggested that a pilot might be subjected to adrenalin adjustment. He could see little justification for the ethics of replacing a human pilot in transport aircraft. There was, he suggested, essential mistrust of a black box in sole command.





R·A·F 'VALIANTS' REFUEL IN FLIGHT

Probe and Drogue adopted for V-bomber force

FLIGHT REFUELLING gives to our V-bombers advantages which stem from greatly increased range and striking power.

This valuable facility of being able to refuel in flight can be applied quite easily to most modern aircraft without structural alteration—a point becoming increasingly appreciated by other countries. (Probe and Drogue is standard equipment in fighters of the U.S. Navy and U.S. Tactical Air Force.) Conversion is simple and straightforward and the cost is agreeably low, particularly in terms of time, labour and weight. Equipment for the tanker aircraft, for example, is a self-contained "package" unit which can be fitted or removed in a few hours. Operation calls for only the briefest instruction.

Refuelling the Valiants in flight requires no addition to normal aircrews. From a remote control panel on the tanker the complete fuel transfer operation is controlled safely and semi-automatically by one man. The probe of the receiving aircraft is flown into the drogue and withdrawn when its tanks are full—the connections being made or broken entirely at the discretion of the receiver pilot.

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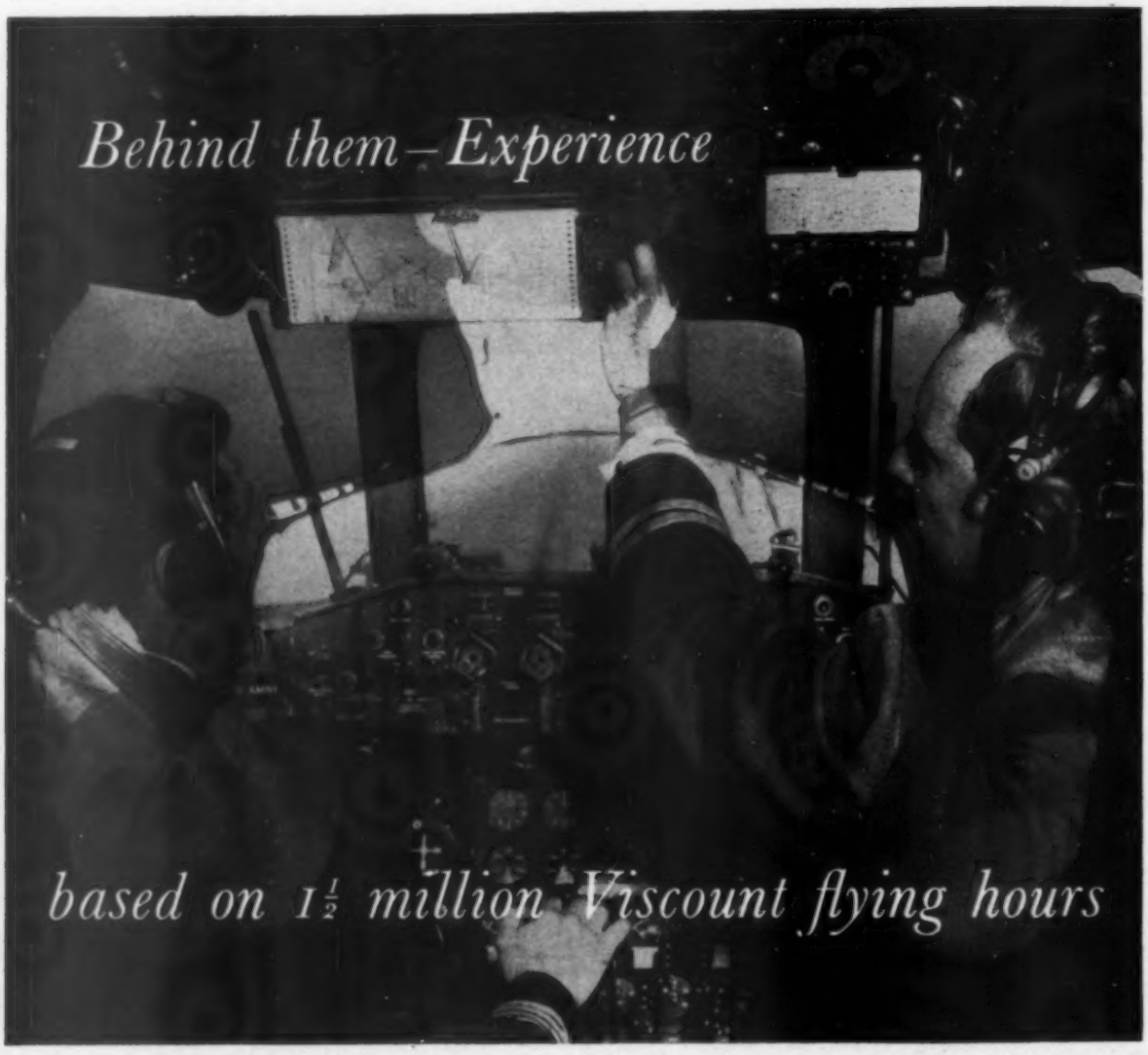

Aer Lingus Success

Mr. J. F. Dempsey, Director and General Manager of Aer Lingus, said recently, "Our fleet of Viscounts played a major part in the success of our twenty-first year of operation, enhancing both our prestige and our business. They have enabled us to provide our passengers with a higher standard of complete comfort and speed. Our salesmen have had something extra to 'sell' in the Viscount and as a result our traffic has shown a steady increase since we acquired these excellent aircraft."

Pilots have many reasons for preferring the Viscount with its proved and reliable non-powered flying controls.

Viscount experience in service with over 20 airlines is being built into the simple functional cockpit and cabin layout of the new Viscount 810-840—ensuring for both pilots and passengers that comfort and freedom from strain which is now associated with Viscount travel. In this new Viscount the proved dependability of the airframe and the Rolls-Royce propeller-turbine, after ten years of development and 1½ million flying hours, means peace of mind for both crew and passengers. Quiet, smooth flight reduces fatigue and improves efficiency, while the rapid turnround due to ease of maintenance means less worry over schedules.

There is no substitute for experience

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

TGA AT548G

The speed with which Boeing are putting the first 707 together is evident from this new progress picture when it is compared with the previous one in "Flight" nine weeks ago. All four J57 engines and the undercarriage are now installed. Roll-out will be next month, the first flight in December, and delivery to PanAm in December 1958.

CIVIL AVIATION

C. OF A. FOR THE BRITANNIA—

THE news last week that the Britannia 310-series had been granted a full Certificate of Airworthiness came as a surprise: it had been generally assumed that the award of a C. of A. might have to abide the outcome of engine icing trials across the North Atlantic.

The special circumstances attending the issue of this C. of A. prompted the Minister of Transport and Civil Aviation, Mr. Harold Watkinson, to issue a statement last week (September 19) and to hold a press conference. Extracts from the official Ministry statement follow.

"Mr. Harold Watkinson, M.P., Minister of Transport and Civil Aviation, has approved the recommendation of the Air Registration Board that a normal certificate of airworthiness for the public transport of passengers should be accorded to the Britannia aircraft 312 and 313. The relevant Flight Manual which is an integral part of the Certificate of Airworthiness states *inter alia* that prolonged flight in cloud at altitudes above 16,000ft in a narrow band of temperature about the freezing point and in heavy concentration of water or ice should be avoided. The statement is expressed in the form of advice to the operator and is therefore not a mandatory limitation. It is quite usual in Flight Manuals to include advice affecting operations.

". . . Further operating experience [has shown] that although the engine as modified could cope satisfactorily with dry ice, it could still be affected by certain conditions of ice crystals and water occurring together. The problem posed by this fresh discovery has yet to be fully solved but the Gardner Committee is hard at work and a number of promising lines of investigation are being urgently pursued. In the meantime, the Minister is advised that the aircraft can be flown normally provided due regard is paid to the advice in the Flight Manual. With this in mind he has accepted the recommendation of the Air Registration Board."

It is understood that Proteus icing takes place in atmospheric conditions which are a combination of the following: (1) cloud, (2) an ambient temperature between 0 deg C and −8 C, (3) altitudes between 16,000ft and 20,400ft, (4) temperatures between I.S.A. +13 and I.S.A. +22, (5) a ground water-level content of 13 gm/cu m.

Bristol's next hurdle is U.S. certification of Northeast's five Britannia 305s, the first of which was due for delivery in October. According to the American *Aviation Daily*, delivery has gone back to January, and the same source reports that the American C.A.A. were "surprised" to hear that no cure had yet been found for the Proteus icing problem. At the worst, C.A.A. may now say that the Britannia cannot be certificated until the icing problem is cured. But the optimistic outlook is that they will accept the A.R.B. view and—pending Northeast route proving flights during October and November—will award a full U.S. certificate with the advisory condition written into the Flight Manual.

Footnote: In a recent statement, Bristol remark: "Flight trials recently carried out with production 310-series aircraft have indicated that they will meet contractual range requirements in all respects and that they are not, as was inferred from the performance of the prototype, deficient in performance to the extent of 7 per cent. Thus there is no longer any reason to suppose that the aircraft lacks the range necessary for regular non-stop services on the North Atlantic."

—AND THE PROTEUS IN PERSPECTIVE

THE Britannia 102's Proteus 705 turboprops have been in such bad odour of late that it might be as well to record a cheerful fact or two about this engine's general behaviour in B.O.A.C. service. If it is accepted that the ultimate judgment of a transport engine must rest upon (1) the number of times it has been feathered in the air and (2) its overhaul life, the Proteus does not show up at all badly. Here are the feathering facts as sought by *Flight* (they were not handed out generally as a palliative for recent adverse publicity).

The number of times B.O.A.C. Britannia 102 Proteus 705 engines have been feathered in the air since the start of public service on February 1 last from all causes (including icing) is 17. Related to the 59,477 engine hours flown from February 1 to September 15, this represents a feathering rate of about one per 3,500 hr, say about .286 per 1,000 hr. Comparing this with figures recently issued by T.C.A. for their 1955-56 operations, the Proteus feathering rate was less than a third of that for the Wright R3350 engine of the Super Constellation—an American piston powerplant of comparable shaft power which had been in service for more than a year.

How about the 49 unscheduled Proteus removals quoted by B.O.A.C.? This represents a rate of 1.2 per 1,000 engine-hours, which—though far from good—compares with .82 per 1,000 hr for T.C.A.'s Super Connies in 1955-56, and about 2.4 experienced by one big U.S. domestic operator with one type of aircraft so far this year. (The same operator has, incidentally, had three cases of all four engines out through icing.)

So far as overhaul life is concerned, the Proteus seems to have little to be ashamed of. It entered service on February 1 last at 650 hr, went to 850 hr on May 16, and was last week (September 18) A.R.B.-approved for 1,050 hr. Thus the Proteus went from 650 hr to 1,050 hr in 7½ months—a rate which has probably never been equalled by any transport aircraft engine, and certainly not by one in the same power category. The Rolls-Royce Dart—epitome of reliability—actually took 11 months to rise from 600 hr (November 1953) to 1,050 hr (October 1954).

The next stage in the Proteus life may be 1,250 hr, and if the record to date is a guide, this may be achieved within six months. The Proteus will then compare in overhaul life with any of the big American piston engines. At 1,050 hr it is already in the same class as the DC-7C's and L.1649A's Wright Turbo Compound engines.

COME TO BRITAIN

IN many respects, the interests of Britain's airlines and those of the British Travel and Holidays Association coincide: consequently, airline operators will find much food for thought in the B.T.H.A. 1956-57 report. In the 29 years since its formation, the Association has campaigned vigorously to attract visitors to Britain, and a measure of its success is that in 1956 "tourism was again the country's greatest single net U.S. dollar-earning export."

But much remains to be done if the annual increase in tourist traffic of between 5 and 10 per cent is to continue. "It is not possible," the report states, "to meet the demands of twentieth-century travel with nineteenth-century equipment and outlook." It goes on to call for improvement in accommodation and catering, and the removal of "antiquated barriers and formalities which restrict travel across frontiers." These barriers—visa, passport, customs and other controls—are costing the country "at least 100,000 potential visitors a year."

The same problems are spotlighted in B.O.A.C.'s 1956-57 annual report and accounts (see last week): B.O.A.C. fear that their foreign currency earnings from tourism will suffer as a result of the poor accommodation offered, and also recommend that passenger manifests for international air traffic should be abolished and customs procedures simplified.

Another of the many concerns of the B.T.H.A.—and one shared by the airlines—is to encourage travel during the off-season months.

C.A.A. Viscounts and a Hunting-Clan African Airways DC-3 at Ndola airport, Northern Rhodesia. The aircraft in the foreground was used by the Queen Mother during Her Majesty's visit to the Federation; it is the first C.A.A. aircraft to have been equipped with weather radar.

CIVIL AVIATION . . .

HUNTING-CLAN REBUFF

FOR the second time within a few months, Hunting-Clan's hopes for an extension of their African services have suffered a setback. The echoes of harsh words exchanged in the C.A.A.-B.O.A.C.-Hunting-Clan controversy earlier this year have not long died away; it will be remembered that in May Hunting-Clan's bid for a controlling interest in C.A.A. failed and that, instead, B.O.A.C. concluded a ten-year agreement with the African airline.

Now it has been announced that the British independent's application to extend its existing services in Rhodesia has been refused. An official statement by the Central African Air Authority said that the licensing of additional third-class passenger and cargo services would result in "uneconomical overlapping" with C.A.A.'s operations on these routes, and it would be against the public interest to let Hunting-Clan enter the market.

Following this news, Mr. Tom Lawler, general manager of Hunting-Clan African Airways, commented that his company was assessing what "this regrettable decision" meant in terms of commercial opportunities in the Federation for other than the State-owned air transport corporation (C.A.A.). Did the Government desire any private enterprise participation? He added that his airline's present operations would not be affected until a full review of the situation had been made.

I.C.A.O. COMMUNICATIONS DIVISION

THE sixth session of the I.C.A.O. Communications Division convened in Montreal on September 10 with representatives from 31 member states attending. The delegate from Ireland, Mr. G. E. Enwright, was elected chairman of the session. Mr. Walter Binaghi, president of the council, stressed the need for the Division to elaborate the tools and techniques that would permit the air traffic and meteorological services to perform the tasks required of them for the safety and efficiency of air navigation.

Implementation throughout the world had been encouraged, but deficiencies existed in many regions, mainly because of shortage of funds and trained personnel. The Division should try to ensure that all the Standards and Recommended Practices were prepared carefully, were practical, were acceptable to States, were capable of development and did not require frequent or drastic changes.

The sixth session is expected to last five weeks; and in that time it has to consider, amongst many other items, automatic selective calling systems (Selcal); single-sideband radio techniques; standardization of secondary surveillance radar; exchanges of views on long range aids; and the development of techniques and procedures for tape relay operation to facilitate the evolution of automatic point-to-point message relay systems.

THE CINEMASCOPE APPROACH

FAMILIARIZING a pilot with a new route is a big item in an airline's budget, and is an aspect of crew-training about which there has been a good deal of controversy. Should route-familiarization be a matter for legislation, or should it be left to the conscience and commonsense of operators? In practice the requirements have defied precise legislation, and as a result responsibility will—next December—be left to the consciences of the airlines.

But whether a matter for conscience or legislation, route-familiarization will always be a costly business. This is why B.O.A.C. have just completed the most ambitious film in their series designed to show pilots the ins and outs of particular airports. The first three, dealing respectively with London, Darwin and Sydney, were successful enough to encourage B.O.A.C.'s Technical Film Unit to tackle the most difficult airport of all—Kai Tak, Hong Kong, the famous approaches to which demand the most exacting airmanship in the air transport business.

Flight saw the film a few days ago. Made in colour, and in wide-screen CinemaScope, it leaves the viewer with the impression that he has really experienced these remarkable approaches. The local topography, circuit-pattern, and overshoot tracks are lastingly imprinted on the memory, and vaguely familiar names like Stonecutter's Island, Cheung Chau, the South-East Gap, and Waglan are really brought to life as vital landmarks on the approaches to Hong Kong's two runways. All the sequences are shot in low-visibility as well as in clear conditions, and a few bumpy, rain-lashed moments early on introduce the audience to a Pacific typhoon. The film took three months of waiting on location for the right conditions; and because it shows Hong Kong from every angle and in every meteorological mood, it packs a lifetime's experience of the place into its 55 minutes. The filming was the work of Mr. W. E. Oliver, B.O.A.C.'s technical photographic officer, who operated from the right-hand seat of Cathay Pacific's DC-3. The technical adviser was Capt. J. Raeburn, a B.O.A.C. captain who has made nearly 1,000 landings at Kai Tak.

What such films will mean in terms of £.s.d.-saved remains to be seen; but as airport simulators they are likely to become as familiar a part of the training system as aircraft simulators.

CONTINUED JOINT CONTROL FOR T.E.A.L.

THE Australian and New Zealand civil aviation heads have recently made it clear (see last week's *Flight*) that there will be no change in the existing operation of Tasman Empire Airways as an enterprise owned jointly and equally by Australia and New Zealand. (It has been suggested for some time that Tasman might become entirely N.Z.-controlled.) It was accepted that possession of some long-range aircraft (to be listed on the N.Z. register) and the provision of maintenance facilities and staff in New Zealand were of vital importance to that country, and Australia had agreed to co-operate in providing opportunities for the adequate and economic upkeep of such aircraft, "if necessary in some form of association with Qantas." Planning for the replacement of T.E.A.L.'s existing fleet would proceed and the result of this planning would be considered by the Australian and New Zealand governments in due course.

AN AIRPORT FOR TEES-SIDE?

A SUGGESTION has been advanced by Mr. F. R. Shaw, senior vice-president of the Tees-side and West Durham Chamber of Commerce, for an airport to serve both the Tees and Tyneside and located between the two rivers. This idea was put forward as an alternative to Greatham Airport (which, it was stated, had failed owing to lack of Customs facilities) and Woolsington, which was too far away from Tees-side patronage. The Minister of Transport and Civil Aviation, in response to a letter from the Chamber asking that steps be taken to provide a suitable airport, asked if anything could be done to stimulate traffic from Woolsington; a reply which Mr. Shaw described as "most unexpected."

The president of the Chamber is to take the matter up personally with the Minister and a committee has been formed to discuss Tees-side facilities.

THE LAW IN THE AIR

NOW meeting in Tokyo, under the presidency of Prof. A. Ambrosini, are thirty delegates of I.C.A.O.'s Legal Committee. Their deliberations mainly concern the interchange of aircraft (and operating aircrew) between airlines of different nationalities and whether this is contradictory to the provisions of the Chicago, Rome and Warsaw international conventions. Such weighty legal problems are not easily resolved (there have been previous I.C.A.O. meetings at The Hague, Caracas and Madrid) but it seems probable that the assumption that the nationality of an aircraft is the nationality of the company using it will form the basis of new protocol. This would satisfy the provisions of the Rome Convention concerned with *Damage Caused by Foreign Aircraft to Third Parties on the Surface.* The U.S.S.R. has sent observers to the meeting.

THE PLESMAN MEMORIAL LECTURE

WE summarized last week the first part of the Dr. Albert Plesman Memorial Lecture given in Delft by Mr. A. E. Raymond, vice-president engineering, Douglas Aircraft Company. Below are further salient quotations from the lecture.

"What will happen to the route structure over which people will fly in the next ten or 15 years? Is it going to change, when considered against the background of a world pattern? There is one thing that is quite certain; the segment of the globe described by a circle roughly 6,400 st m radius based on, say, Amsterdam, will embrace practically all the important capitals of the world. . . . It is not difficult to foresee a single-stop operation connecting the most distant capitals in less than a single day's flying. Thus, essentially, we can at least discern a glimpse of the necessary practical range of the air transport of the future."

"An ideal international route structure is difficult of achievement . . . this causes us to make aircraft which are really heavier than strictly necessary, and to increase the actual cost of air transportation to the travelling public. It is to be hoped that all the talents devoted to its service will succeed in combining to construct a rational scheme of route systems on a truly international footing . . . with the participation of the U.S.S.R. and China. The ability to fly true great circle distances would be of inestimable value to world aviation."

"With an increasing demand for traffic routes in order to provide a direct end-to-end service, there is naturally speculation as to what the effect will be on the international traffic handled at the older gateways. There will be, quite naturally, many heart-searchings amongst operators who feel that their domestic and other long-cherished routes are being infringed upon."

"As the number of international gateways increase, it can be foreseen that short-haul operators will play an increasingly important rôle as interline feeders in addition to their inter-city function. They will be able to draw on increasingly diversified concentrations of population; which will in turn feel more closely connected with an integrated world traffic pattern. This will tend to attract more and more commerce to areas now considered agrarian rather than urban; so that it is possible to discern the beginnings of an increasing traffic spiral."

"The absolute essence of the entire [air traffic control] scheme is a fanatical attention to punctuality by all concerned with operations. Where random arrivals do occur, it has been clearly established that the allowable average rate of arrival must be about one-half the airport's possible landing rate. Such halving of the capacity available is unthinkable."

"Thousands of Americans, Europeans, Africans, Australians, Indians, etc., have encountered each other at homes and offices all over the globe. As we talk to each other, we recognize a community of interest and a reaction to world social and economic and technical conditions which transcends factors of language, dress and religion.

"Air transportation—and air transportation *only*—offers the citizens of the world the opportunity for rapid long distance complete communication—unimpeded by geographic barriers. There are, however, both technical and political hills to climb before complete freedom of communication and travel become possible.

"The jet transport has brought us near the top of the technical hill. May I express the thought that an equal step in the realm of international understanding will bring us to the verge of Plesman's goal—that 'The oceans of the air shall unite all people.' "

Capt. F. K. Bainbridge, D.F.C., recently received the B.O.A.C. Certificate of Commendation from Mr. Gerard d'Erlanger for his "one-wheel" Constellation landing at L.A.P. on August 11. Looking on is Capt. J. N. Weir, chief of flight operations.

BREVITIES

UNCONFIRMED reports last week-end suggested that B.O.A.C. had agreed to release four Britannia 312s to Howard Hughes upon payment of £3 million compensation.

* * *

Grumman's twin-Dart competitor to the Accountant, the Design 159 (*Flight*, July 19), has been named Gulfstream.

* * *

Another potential Friendship purchase is Aviacion y Comercio of Spain.

* * *

The de Havilland Comet 3 prototype is to be flown to South Africa for tropical tests next month.

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It is reported that American Airlines have notified Douglas that they have deferred plans to purchase a fleet of DC-7D (Tyne turboprop) cargo aircraft, owing to financial difficulties.

* * *

Czechoslovak Airline's three Tu-104As are now being delivered, and are due to start services to Moscow, Paris, Cairo, Damascus and Beirut in October.

* * *

Present in force at I.A.T.A.'s annual meeting in Madrid were engine manufacturers D. Napier and Son, Ltd. They entertained 117 guests to a buffet lunch on the first day and over 60 a day thereafter.

* * *

A 230-acre site at Tulsa Municipal Airport will be used for an American Airlines maintenance and overhaul base. It will cost over £7 million and is scheduled for completion in 1959.

* * *

The Australian Prime Minister, Mr. Menzies, said that his government would not develop airports to take larger aircraft than the DC-3: instead, it would encourage operators to "buy modern pressurized aircraft such as the Handley Page Herald or the Fokker Friendship which would be able to use existing airports." According to an American source, A.N.A. (now owned by Ansett, and previously associated with the Herald order-book) are now likely to order Friendships.

Two surveillance radar systems have been ordered from Marconi by the New Zealand Government.

* * *

B.E.A. are to inaugurate on October 7 a four-times-weekly service between London and Tel Aviv.

* * *

East African Airways have inaugurated a new Canadair Argonaut service to Karachi and Bombay *via* Aden.

* * *

Aeronaves de Mexico and Flying Tiger have been admitted to associate membership of I.A.T.A., bringing the total membership to 80.

* * *

Pacific Southwest Airlines, who had previously placed an option on Caravelles, have now decided to buy Lockheed Electras. An order for three brings the Electra order-book to 143. As *Flight* went to press, A.N.A. also announced an order for four Electras for delivery from December 1958.

* * *

The "termination of services between the U.S.A. and France" was recently a possibility, according to American sources. It was reported that the French, who want Californian rights for Air France, had threatened to disallow PanAm's Polar inaugural service to Paris on September 13.

* * *

The fifth meeting of the Commonwealth Advisory Aeronautical Research Council is in session at Montreal until October 5. The British delegation is led by Mr. A. E. Woodward-Nutt. Other delegations are from Australia, Canada, New Zealand and South Africa.

* * *

Mr. Carter L. Burgess, president of T.W.A., in reporting an improvement in the airline's trading position this year, added: "there are still situations that need correction. We still have too many flights returning from the runway. There is far too much equipment substitution. The Jetstream first-class passenger loads are too low. The departure performance record at Idlewild on both the domestic and international flights must be improved."

Croydon is London's airport for business and charter aircraft. Here at Croydon on a recent weekend in September, are a Chipmunk, E.P.9, Dove, Heron, Single and Twin Bonanza, Norécrin and two Safirs. "Flight" photograph

An Airport's Struggle for Survival

By A. T. PUGH

Croydon Under Sentence

THE past ten years should have made us wary about under-estimating the growth of air transport. We live in a world which seems continually unable to keep up with the hungry demands for more facilities, more equipment, more airports. In Great Britain, we talk about a third airport for London (having advocated the expenditure of another £17 million on the £30 million original)—yet in the same breath talk about closing down Croydon. It may not be an exaggeration to say that if, in fact, London does throw away Croydon, future historians may judge that we threw away with it a vital part of our capital's commerce.

THE sands are running out for Britain's most historic airport. The exact day of demise has not yet been set, but the method of execution has. It will be death by strangulation; a cessation of flying, a gradual running down of facilities, and the creeping urban paralysis of houses and shops spreading across the face of a once-fair field. The bustling activity of business and charter flying, scheduled flights and training programmes will be shouldered out—so that the grass acres, the hangars and administration buildings can be sold to offset a little of the cost of doubtfully adequate Gatwick Airport to the south.

This is not execution as the result of a process of natural evolution. It is economic murder, and it is likely to be committed for the most tragic reason of all—a failure to appreciate that the victim has not only the right, but ample justification, for survival. Not because of the airport's historic associations, great as they are (recall the flying training of King George VI, the D.H. Comet's departure for New Zealand, the birth of Air Transport and Travel, Instone Air Lines, the growth of Imperial Airways), but because Croydon *is an essential London airport*. It is not sufficient to argue that it must be closed because it cannot be developed into an airport for modern commercial transports when the urgent needs of other spheres of civil air commerce are overlooked. It seems unthinkable that Croydon's advantages of geographical position, developed installations, hangarage, repair and maintenance facilities and a size and surface sufficient for aircraft of 25,000 lb gross weight should be dissipated at a time when the growth of air traffic is so rapidly outstripping the most carefully calculated forecasts of a few years ago.

The need is so obviously for *more* airports for London, not for less, that one so advantageously situated as Croydon can never outgrow its usefulness. Indeed, the number of movements at Croydon has more than doubled since 1953, and in the past 12 months was a record 75,500.

The development of "The Airport of London" at Croydon was no accident; it was a logical choice of location, half an hour by car from the city and beyond its suburban fringe. That houses have been built around the airport's periphery in no way affects the right of aircraft to operate; Gatwick and London are similarly affected, and complaints of noise (and not very much noise) come ill from those who buy seats too near the band. Even if the journey to Croydon now takes 45 minutes from London, it is still the only developed business-airport of useful size within anything like easy reach of the city centre. And rather than outgrowing its usefulness, Croydon's airport is ideal—in size and situation—for the development *and active encouragement* of the important field of executive, business and charter travel.

There is every reason to forecast an expansion of this aspect of the civil aviation business, an active nucleus of which already exists at Croydon. A European free trade area—when it comes—should bring an increasing executive interchange between European capitals; a function ideally suited to the range and capabilities of the new generation of business aircraft appearing on the world's markets. Encouragement of a home market for British aircraft of this type—so far woefully lacking—could also result in good business from abroad, both in the purchase of aircraft and the less tangible economic advantages of more business being brought to the nation's capital. Croydon could become for London what Teterboro is for New York; a thriving, prosperous airport geared to the needs of the private and executive aircraft pilot. Customs clearance would be rapid (because of individual treatment); there would be facilities for hangarage and refuelling, and provision for occasional repairs to visiting aircraft by maintenance facilities such as exist there today.

If Croydon is not to supply this service, which airport is there that will? Not London Airport, long effectively closed to this type of aircraft; nor Gatwick, once to be the new home for all of Croydon's operators, but now soon to be heavily committed with the commercial overflow from L.A.P. and those independents who urgently require the facilities the latest airport can offer.

A new home for Croydon's private and business aircraft and flying clubs is a question on which Mr. Harold Watkinson, the Minister of Transport and Civil Aviation, is "still consulting with the Secretary of State for Air." The prospects—if the Ministry is not to discourage utterly a traffic responsibility which it should nurture most carefully—are bleak. As each possibility is examined, the practical choice dwindles. Blackbushe is too far from London for the purpose and would present an uncomfortable variety of traffic in the circuit. Biggin Hill has been suggested; but access is poor, terminal facilities do not exist, and the air traffic control problem rivals that of Croydon. Even Southend has been considered; but Southend has been earmarked as a second alternate to London, the need for which was appreciated by the Millbourn Committee in their report on the development of London Airport. "We recommend," they said, "that early consideration be given to Stage 2 of the Gatwick plan and also to the possibility that yet a further airport will need to be developed by 1970."

There are slender possibilities of developing smaller aerodromes such as Kenley, Fair Oaks or White Waltham, but only at the price of rejecting Croydon's obvious advantages of facility and location. It is doubtful if the effort would be worth the candle. Even north of London, further from the short sea crossings to the Continent, the choice is meagre in the extreme. Elstree has but one runway, Denham and Panshanger are too small, Luton and Stapleford

Tawney too far from the city centre; by its very nature, super-short-haul traffic demands that surface travelling time be kept to an absolute minimum. This is the basis upon which inter-city centre helicopter STOL and VTOL services justify their relatively low cruising speed and—as there is yet no heliport or STOL base within the Metropolitan area—Croydon might well supplant Gatwick to become an ideal proving ground for the first experimental services.

Aeronautical prophecy is an art too fraught with pitfalls for dogmatic assertions to be made with safety. Before Croydon is dismissed as redundant in the scheme of London's airports it might be as well to recall Mr. A. V. Cleaver's remarks in an article in *Flight* for March 15 that most prophets are optimistic about what can be done within five to ten years but their pessimism about the possibilities for the next ten to fifty years has verged on the ludicrous. Even if it cannot be foreseen (though to a worthwhile extent it can) how Croydon will be needed five, ten or fifteen years ahead, it is still an act of irresponsibility to allow the airport to be closed (in the words of Mr. Airey Neave) for "the obvious economies which it would give in running costs, manpower, etc., [and for the] substantial value from its sale, which will balance in some part the very heavy cost of building Gatwick."

The possibility of helicopter services into Croydon has not been overlooked by the Ministry of Transport and Civil Aviation—but only as a passive result of "helicopters coming into general use for air services" when the airport is closed. The Ministry's thinking on this point is by no means clear; Croydon's residents have been promised a reduction in noise level when the aerodrome "begins to run down next year," but are subsequently threatened with equally noisy helicopter services. The M.T.C.A. is right to consider carefully—in spite of arguments as to "who was there first"—the reactions of residents to the aerodrome on their doorsteps. But the Croydon Chamber of Commerce (many of whose members, in their private lives, are Croydon residents) say that complaints of noise come from a "vociferous minority," and they themselves are campaigning actively for the retention of the town's airport and the employment and prestige which it provides.

In correspondence that has passed between the M.T.C.A. and the Chamber since the latter laid an appeal before Mr. Airey Neave, Joint Parliamentary Secretary to the M.T.C.A., the Ministry concur that "there are substantial and cogent arguments for both sides" on the decision to close Croydon airport.

Briefly, the M.T.C.A. case for closing is that increased activity since the decision was made in 1953 in no way affects its suitability; for overall economy the land can be better used; the availability of Croydon cannot ease L.A.P.'s problems, and the airport cannot remain open because of the conflict between its air pattern and the patterns of the other London airports.

For their part, the Chamber of Commerce support the retention of Croydon by declaring that business at Croydon is increasing to an extent where—even when some of the larger operators move to Gatwick—the other operators and maintenance companies will be cramped for space; an alternate to Gatwick and London is required [this is hardly valid; an additional Customs airport is what is needed]; Croydon provides the only convenient pilot-training airfield for South London; it is an *active business airport* and it provides an excellent base for repair and maintenance with adjacent facilities for testing. They also claim, with every justification, that air traffic control should be the servant of aviation and not its master.

Even if—as is suggested here—it is accepted that the value of Croydon is as a business and charter London airport in its own right, the problem of its air traffic control seems likely to be a sticky one to solve. With the separation standards demanded by the accuracies and workload on the airborne and ground aids now in use, delays occur at London Airport when aircraft from Croydon elect to fly airways, because the altitudes they are using are frozen to other traffic.

The magnitude of the problem that presents itself when the integration of the traffic patterns of London, Gatwick and Croydon is considered is such that the M.T.C.A. has advanced the difficulties as a major reason for closing Croydon. Here is a problem to test the mettle of such men as the Guild of Air Traffic Control Officers.

At first sight it certainly seems unlikely that Croydon aircraft will be able to continue to use airways—at least until better short-range navigation aids and radar are available—and Croydon's scheduled service operators might do well to re-examine from the point of view of regularity their decisions not to move to Gatwick.

But to close the airport on this ground to business and light aircraft is obviously unsound, and a short-term answer to Croydon's air traffic control problem might well be in the extension of the present "free-lane" system, which can be operated in considerably poorer weather than the present standards of V.M.C. (which are unlikely to survive much longer). Such a system, given co-operation (and it does not seem unreasonable to demand that all except local flights should carry radio) is a practical proposition. The principle is to select routes from the airport which, because they follow landmarks such as railways or rivers, can safely be flown in "contact" conditions and would define a path along the narrow gap between the London and Gatwick Control Zones.

Access to the sector to the north and east of Croydon—unfortunately the least used—presents few difficulties, but its availability could prove valuable in keeping Croydon in use. The most critical outbound track is to the west, where the present south-east free lane could be retained and extended along the Redhill, Dorking and Guildford railway line at a maximum height of, say, 1,500ft. For further navigational aid there is a clearly-defined escarpment between Redhill and Guildford, where the lane would "cone-out" free of London Control Zone to give access to the south-west. This cone would be laid out to avoid conflict with the circuits of Farnborough and Blackbushe and, to the south, Lasham and Odiham.

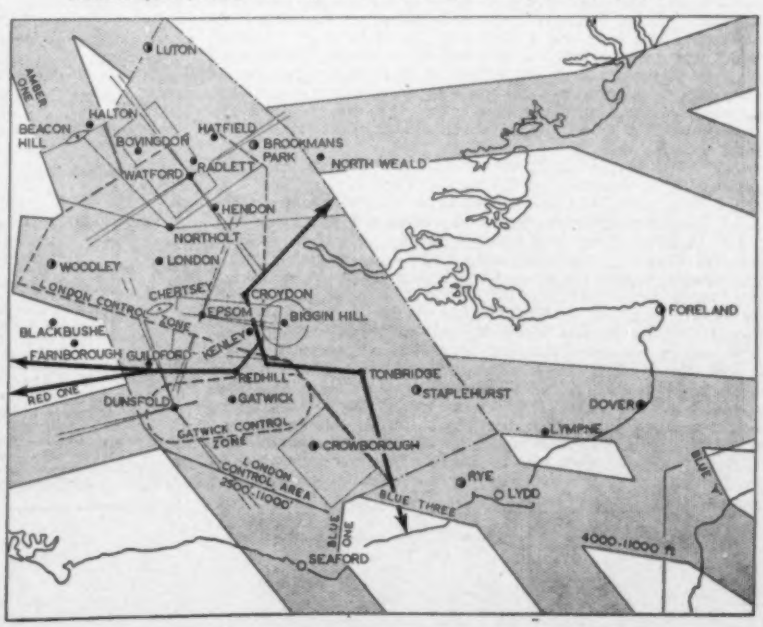
Also in great demand is access to the south, for flights to the south coast, Jersey and the Continent (the usual crossing for light aircraft is Dungeness - Le Touquet). The Gatwick control zone must be avoided (Gatwick aircraft might be routed to climb out over Crowborough), so a possible free-lane route is *via* the present S.E. free lane to the Redhill - Tonbridge railway line, along the line to Tonbridge and then in a cone to the south. A better route might be to fly to Tonbridge direct, but this lane would not be well defined. Traffic approaching London in this sector is flying at 6,000ft and would not be a danger, but careful consideration would have to be made of the needs of West Malling and—if it continues in operation—Biggin Hill.

Visual marking of the free lanes is, at first sight, a very attractive proposition; but previous experiments have shown that when conditions were bad enough to make lights necessary, the markers could not be seen. Nevertheless, this aid should be practical provided that there are sufficient markers, they are of the latest high-intensity type, and the weather minima are not too low.

A free-lane system for Croydon is, at best, a short-term solution only. But it might suffice until the development of an integrated London air traffic control system—including Croydon as London's business airport—materializes.

The axe over Croydon's head is suspended there with the intention of ending—come what may—an airport that in 1953 was decreed "unsuitable for development" as an alternate to London Airport. But in five years of this fast changing aviation business the White Paper of that time has become as outdated—and has been shown to be as unimaginative—as the contemporary forecasts of future traffic. A civil aviation growth curve that sees a doubling of traffic every five or six years is sound justification for the survival—and the active encouragement—of a businessman's London airport. For once the irrevocable step of closing-down Croydon has been taken, there can be no looking back; the airport would be lost for ever.

A solution to Croydon's air traffic problem when Gatwick opens might be in an extension of the freelane system, shown in heavy lines on this map of the 1958 Airways System.



CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns; the names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

Butterfly Tail Cluster

I WOULD agree with J. M. Ramsden ("The Short-range Jet Airliner," *Flight*, September 6), that the more one looks at the tail cluster, especially if it be for three engines, the more it appeals to one on all counts.

The case for three engines has been very succinctly put: the advantages, as stated, are obvious. With regard to the disadvantages, I should like to make two points.

(1) In the matter of "selling" an aeroplane by the number of its engines, the public (which in any case is now noticeably more fickle in such matters than was formerly the case) would probably be less impressed by the frankly untidy trappings of the American trio than it was by the sight of an imposing bank of propellers in the days when aircraft were less reliable than at present.

(2) The problem of positioning the third engine might be simplified by the use of a butterfly tail (a possibility which does not appear to have occurred to your contributor), the third engine being mounted between the tail surfaces. The balance case is still good, as should be the intake efficiency. Accessibility would be good, even in the case of the central engine, and structure should be (relatively) simple. The case for and against the butterfly tail has, of course, been well argued, but without the emergence of any definite decision.

I trust, sir, this may shed some small ray of light on what remains a somewhat dark problem.

Great Baddow, Essex. J. R. DANIELS.

Me 109 Production

MAY an American reader agree with Mr. A. Banfill's remarks concerning Me 109 production life? The prototype Me 109 VI flew in 1935, and the last HA-1112-M-1-Ls, Hispano-built variants of the Me 109 G, which had been rebuilt to take the Rolls-Royce Merlin 500-45 and so were virtually new airplanes, were delivered to the Spanish Air Force late in 1956 or early in 1957.

Variants of the Me 109 G and K series were also produced post war by Avia in Czechoslovakia, powered by both Daimler Benz DB605 and Junkers Jumo 211F engines. Some of the Jumo-powered fighters, known as the Avia C.210, were used by the Israeli Air Force in the 1948-49 war.

As an estimated 33,000 of the various versions of the Me 109 were built by the Germans during the war years, it is also quite possible that it was produced in greater numbers than any other fighter.

I have written an article, shortly to appear in an American publication, on the Me 109 saga, and hope to amass enough material for a complete book. I will appreciate any help interested readers can give me on this subject. I particularly desire detailed information on Me 109 (C.210) operations in the Israeli Air Force, and pictures of Me 109s bearing markings other than German, especially Israeli, Spanish, Czech, and Finnish.

478 Hutton Place, Columbus 15, Ohio. JAMES F. CRAIG.

Mixed-class Viscounts

IN the September 6 issue of *Flight*, page 395, the note on the Vickers Viscount states that those of K.L.M. are the first to be operated as mixed-class. This is not so, as those of Iraqi Airways, as used on their flights between Baghdad and London, have been operating with first and tourist classes for over a year.

London, S.W.16. HENRY ROYE.

Supersonic Ban

EXCELLENT though the latest S.B.A.C. Show was, I was rather disappointed with the Ministry of Supply's ban on supersonic flying.

The Farnborough Air Display is the only time members of the public can see the latest types of aircraft demonstrated; and as we—the public—pay for the research and development of these aircraft, surely we are entitled to see them and their pilots showing us what they really can do.

One can appreciate the feelings of people living in the area and also damage to property caused by sonic "booms." But why can't the Ministry concerned make it clear that any such damage incurred will be promptly dealt with and the owners compensated? Providing, of course, these are the reasons for the ban.

Egham, Surrey. D. A. KEEL.

ENGINELESS AEROBATICS

HISTORY was made in silence over Dunstable Downs last Sunday when 18 pilots competed in the first national aerobatic gliding contest to be held in this country. Its rules stated that after being towed to 2,500ft each entrant had to perform a chandelle to the right, a loop, a chandelle to the left and a second loop (rather like some courtly 18th-century dance routine). Thereafter any kind and number of evolutions could be carried out, provided they were completed above 500ft; and finally competitors had to make a spot landing.

Such were the regulations; but because there was considerable cloud in the morning, with bases down to 1,200ft, the rules were modified to allow a release height of 2,000ft and limit compulsory aerobatics to a loop and a chandelle (the latter is an evolution which might be described as an unstalled stall turn). As it turned out, conditions gradually improved; so with greater freedom of choice and a splendid backcloth of blue sky and broken cumulus, excellent exhibitions of sailplane manœuvrability and pilot virtuosity were provided for an enthusiastic and knowledgeable audience.

Members of the Lockheed International Aerobatic Trophy panel—Maj. Oliver Stewart (chairman), Capt. H. S. Broad, J. K. Quill, S/L. C. K. Turner-Hughes, G. A. V. Tyson and A. Cdre. A. H. Wheeler—acted as judges, with additional expert advice from "Bill" Bedford. They took into account not only accurate flying but showmanship, originality and spot landings; and after careful assessment awarded the prizes—which were presented by Admiral Sir Caspar John, Vice-Chief of the Naval Staff—to D. A. Smith, D. H. G. Ince and A. W. Doughty. There was also a special award to Miss Brenda Horsfield, the only woman competitor, who was by no means outshone by her male opponents.

Dan Smith deservedly took the Jack Hanks Trophy for an impeccable display in his Olympia, including five loops, two chandelles, three turns of a spin and a roll off the top, and ending with a well-judged spot landing. David Ince in the new Olympia 403 did three perfect rolls during his demonstration; and Arthur Doughty, who followed him in the Kite II (only pre-war glider in the competition), deservedly won his prize for a remarkable succession of spins and stalls, thoughtfully adjusting his repertoire to his mount's apparent slowness to gain speed but readiness to spin. "Andy" Gough and Geoffrey Stephenson were commended by the judges but disqualified from prize-winning for performing evolutions below the prescribed break-off point.

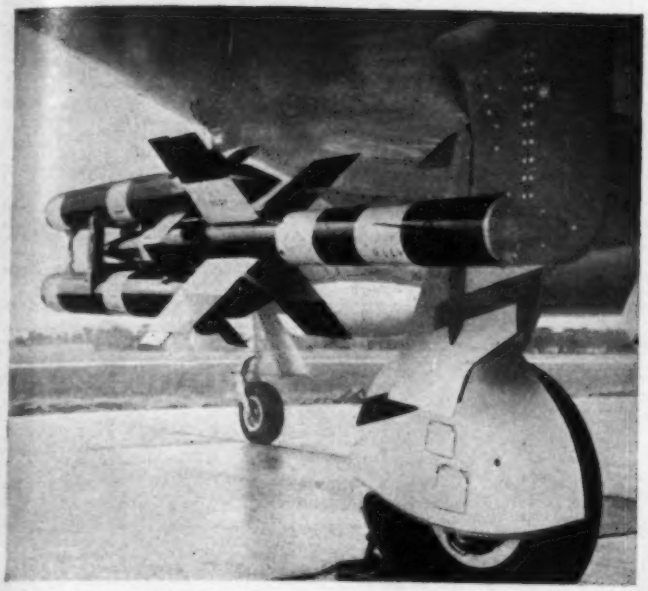
In addition to the gliding, numerous entertainments were provided by the London Gliding Club, who are to be congratulated on their thoughtfulness and efficiency as hosts. It was unfortunate that one of the "turns"—a delayed parachute drop by Mike Reilly—ended in an accident, for by an odd irony he landed on top of the only building in the vicinity (the L.G.C. club-house) and suffered concussion. He was taken to hospital but fortunately found to be not seriously injured.

It was slightly ironical, too, that during the sunny afternoon a crowd larger than that within the paid enclosure gathered on the high ridge to the south-west, where they had a free grandstand view. Perhaps someone from L.G.C. should have taken the hat round up there; but its members were all much too busy in helping to provide an excellent day's entertainment.

FORTHCOMING EVENTS

Sept. 28. **British Interplanetary Society:** "Geophysical Research with Artificial Earth Satellites," by Prof. S. F. Singer.
Oct. 4. **Helicopter Association:** "Tilt Wing Aircraft in Comparison with Other VTOL and STOL Systems," by W. Z. Stepniewski, Dipl.Ing., A.F.I.Ae.S.
Oct. 8. **R.Ae.S.: Section Lecture:** "Some Thoughts on Non-Linear Problems in Aerodynamics," by P. J. Duncton.
Oct. 16. **G.A.P.A.N.: Annual general meeting.**
Oct. 16. **R.Ae.S.: Graduates and Students Section:** "Trends in Air Transport," by P. W. Brooks, B.Sc. (Eng.), A.C.G.I., A.F.R.Ae.S.
Oct. 22. **R.Ae.S.: Section Lecture:** "Aircraft Instrumentation for Flight-test Purposes," by R. I. Duddy and I. McLaren.

R.Ae.S. Branch Lectures (to Oct. 8):—
Oct. 1, *Boscombe Down*, "Study of the Upper Atmosphere Using Rockets," by Dr. E. B. Dorling. Oct. 8, *London Airport*, "Some Aspects of the Development of the Fokker Friendship," by H. Van Meerten; *Luton*, "Human Limitations of High Performance Flight," by S/L. T. C. D. Whiteside.



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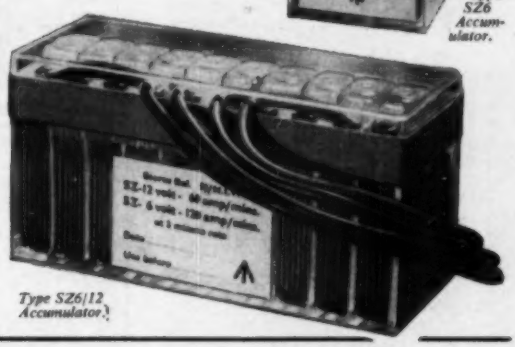

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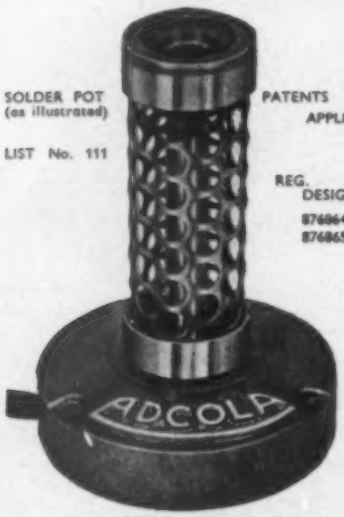

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MILES GEMINI 1IIA. Airframe 311, Gipsy Major 10 Mk. I engines 383, b/f panel, starter, 5-channel V.H.F., C. of A. June, 1960. £3,750.

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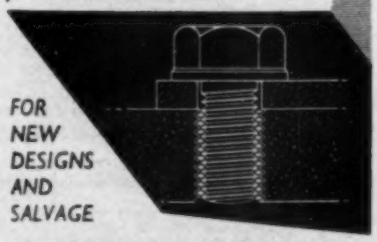

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THE AIR TRANSPORT ADVISORY COUNCIL give notice that they have received the undermentioned applications to operate scheduled air services:—

APPLICATION No. 1456. From Hunting-Clan Air Transport, Ltd., of London Airport, Hounslow, Middlesex, for a Normal Scheduled Service with Viscount aircraft for the carriage of tourist class passengers, supplementary freight and mail on the route London - Lisbon - Las Palmas - Bathurst - Freetown and Accra at a frequency of two return flights per 28 days for a period of 10 years from January 1, 1958.

FROM British European Airways Corporation, of Keyline House, Ruislip, Middlesex:—

APPLICATION No. 1457 for a Helicopter Service with W.S.55 and B.171 aircraft and later with other helicopter types for the carriage of passengers, supplementary freight and mail on the route London Airport and/or Gatwick and/or Southend at a frequency in accordance with traffic demand for a period of 10 years from date of approval.

APPLICATION No. 1458 for a U.K. Internal Service with Pionair, Heron and Viscount aircraft for the carriage of passengers, supplementary freight and mail on the route London Airport and/or Gatwick and/or Southend at a frequency in accordance with traffic demand for a period of 10 years, from date of approval.

APPLICATION No. 1462. From Airwork, Ltd., of Airwork House, 35, Piccadilly, London, W.1, for a Normal Scheduled Service with Viscount aircraft for the carriage of tourist class passengers, supplementary freight and mail on the route London-Lisbon-Las Palmas-Dakar-Bathurst-Freetown-Accra at a frequency of two return flights per 28 days for a period of 10 years from January 1, 1958.

APPLICATION No. 1463. From Eagle Airways, Ltd., of 40, Edgware Road, London, W.2, for a Colonial Coach Class Service with Douglas and Constellation aircraft for the carriage of passengers and supplementary freight between London and Bermuda with an intermediate technical stop at the Azores at an initial frequency of up to four return flights weekly increasing later according to demand during a period of seven years from May 1, 1958.

APPLICATION No. 1464. From Derby Aviation, Ltd., of Derby Airport, Burnaston, Derby, for a Seasonal Normal Scheduled Service with Dakota and Marathon aircraft for the carriage of passengers and supplementary freight between Birmingham and Lyons with an intermediate technical stop at Paris (Le Bourget) at an initial frequency of two return flights weekly increasing to four according to demand during the season April-September inclusive each year for a period of seven years commencing April 1, 1958.

FROM Air Charter, Ltd., of 21, Wigmore Street, London, W.1:—

APPLICATION No. 440/4 for an amendment to the terms of approval of the Vehicle Ferry Service which they are authorized to operate between Southend and Rotterdam until July 7, 1962, so as to permit the carriage of incidental passengers without restriction.

APPLICATION No. 474/4 for an amendment to the terms of approval of the Vehicle Ferry Service which they are authorized to operate between Southend and Ostend until June 30, 1961, so as to permit the carriage of incidental passengers without restriction.

APPLICATION No. 143/6 (Amended). From Derby Aviation, Ltd., of Derby Airport, Burnaston, Derby, for an amendment to the terms of approval of the U.K. Internal Service which they are authorized to operate on the route Nottingham (Tollerton) and/or Derby (Burnaston)-Wolverhampton (optional)-Jersey until September 30, 1959, so as to permit the service to be operated during the extended period March 1 to October 31 each year, an additional four return flights weekly to be operated between Mondays and Thursdays, an optional traffic stop to be made at Guernsey, and integration of the service with the Company's U.K. Internal Service authorized for operation between Oxford (Kidlington) and Jersey.

APPLICATION No. 126/1. From Silver City Airways, Ltd., of 1, Great Cumberland Place, London, W.1, for an amendment to the terms of approval of the Normal Scheduled and Vehicle Ferry Service which they are authorized to operate between London and Le Touquet until March 31, 1960, so as to permit the operation of Dakota aircraft in addition to Bristol 170 aircraft presently authorized.

(Continued at top of column 1, page 24)

PUBLIC ANNOUNCEMENTS

(*Continued from column 3, page 23*)

FROM B.K.S. Air Transport, Ltd., of 1, Marylebone High Street, London, W.1:—

APPLICATION No. 1465 for a Normal Scheduled Service with Dakota, Viking and Ambassador (Elizabethan) aircraft for the carriage of passengers, supplementary freight and mail between Newcastle and Basle with an intermediate traffic stop at Brussels at a frequency of two return flights weekly during a period of seven years from April 1, 1958.

APPLICATION No. 1466 for a Normal Scheduled Service with Dakota, Viking and Ambassador (Elizabethan) aircraft for the carriage of passengers, supplementary freight and mail between Newcastle and Bergen at a frequency of two return flights weekly for a period of seven years from April 1, 1958.

APPLICATION No. 1467 for a U.K. Internal Service with Dakota, Viking and Ambassador (Elizabethan) aircraft for the carriage of passengers, supplementary freight and mail between Newcastle and Belfast (Nutts Corner) at a frequency of 3-6 return flights weekly for a period of 10 years commencing three months after final approval.

APPLICATION No. 1468 for a U.K. Internal Service with Dakota, Viking and Ambassador (Elizabethan) aircraft for the carriage of passengers, supplementary freight and mail between Southend and Newcastle at a frequency of seven return flights weekly for a period of 10 years commencing three months after final approval.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on July 30, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3, Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [7120

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SALARY will be in accordance with the Burnham Technical Scale for men, up to a maximum of £1,025 per annum according to qualifications and experience.

FURTHER particulars and forms of application may be obtained from the undersigned (stamped addressed foolscap envelope). Completed forms should be returned to the Principal, Municipal College, Victoria Circus, Southend-on-Sea, within 14 days of the appearance of this advertisement.

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CHIEF EDUCATION OFFICER,

Education Office,

Warrior Square,

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VACANCY FOR GENERAL MANAGER

CENTRAL AFRICAN AIRWAYS CORPORATION

CENTRAL AFRICAN AIRWAYS invites application for the post of General Manager. The successful applicant will be required to commence duty on January 1, 1958. Salary will be in accordance with experience and qualifications.

APPLICATIONS should be addressed to the Secretary, Central African Airways, Salisbury, Southern Rhodesia, so as to arrive not later than October 31, 1957. Envelopes should be endorsed

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ENGINEERS, preferably graduates, are invited to apply for a responsible and interesting position dealing with the fatigue and stress problems of this leading aeronautical company. Some previous experience in the work is desirable, and suitable candidates will be considered for a senior appointment.

Please write in confidence, to the

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DE HAVILLAND PROPELLERS LIMITED,

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[7133

FLYING Instructor required for regular part-time duties, mainly at weekends. Must be prepared to instruct conscientiously, in an orthodox manner and to strict standards. Written applications, please, to the Chief Instructor, Elstree Aerodrome, Herts. [7109

HANDLEY PAGE (READING), LTD., The Aerodrome, Woodley, Reading, have vacancies for Senior and Intermediate Draughtsmen for interesting work on Civil Aircraft. High commencing salaries are offered and a generous Life Assurance and Superannuation Scheme is in operation. Please send full particulars of experience, etc., to the Personnel Officer. [0284

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2. **AERODYNAMICIST OR MATHEMATICIAN** for work on flutter, vibration, and general aeroelasticity. Some experience in this field is preferred with a knowledge of analogue and digital techniques as applied to the subject. A degree or similar qualification necessary.

3. **AERODYNAMICIST** to be responsible for operation and development of an analogue computer and simulator installation. Some experience in this field is required, but consideration will be given to applicants with experience of flutter and stability, or servo-mechanism techniques. A degree or similar qualification necessary.

All the above vacancies are progressive, and offer salaries commensurate to the position, with excellent conditions of employment, superannuation and all welfare facilities.

Applications marked 'confidential' for position (1) to the **Chief Aerodynamicist** and (2) and (3) to the **Personnel Manager, Folland Aircraft Ltd., Hamble, Hants. (Telephone Hamble 3191.)**

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(*Continued from column 3, page 23*)

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APPLICATION No. 1465 for a Normal Scheduled Service with Dakota, Viking and Ambassador (Elizabethan) aircraft for the carriage of passengers, supplementary freight and mail between Newcastle and Basle with an intermediate traffic stop at Brussels at a frequency of two return flights weekly during a period of seven years from April 1, 1958.

APPLICATION No. 1466 for a Normal Scheduled Service with Dakota, Viking and Ambassador (Elizabethan) aircraft for the carriage of passengers, supplementary freight and mail between Newcastle and Bergen at a frequency of two return flights weekly for a period of seven years from April 1, 1958.

APPLICATION No. 1467 for a U.K. Internal Service with Dakota, Viking and Ambassador (Elizabethan) aircraft for the carriage of passengers, supplementary freight and mail between Newcastle and Belfast (Nutts Corner) at a frequency of 3-6 return flights weekly for a period of 10 years commencing three months after final approval.

APPLICATION No. 1468 for a U.K. Internal Service with Dakota, Viking and Ambassador (Elizabethan) aircraft for the carriage of passengers, supplementary freight and mail between Southend and Newcastle at a frequency of seven return flights weekly for a period of 10 years commencing three months after final approval.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on July 30, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3, Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [7120

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INDEX TO ADVERTISERS

	Page
Adcola Products, Ltd.	20
Airwork, Ltd.	Facing Edit. Page 519
Alvis, Ltd.	Facing Edit. Page 518
Armstrong Patents Co., Ltd.	4
Armstrong Whitworth Aircraft, Ltd., Sir W. G.	Cover i
Aston and Co., Ltd., E. S.	21
Automotive Products Co., Ltd.	Cover ii
Blackburn and General Aircraft, Ltd.	1, 23
Box No. 1798	24
B.P. Aviation Service	11
Bristol Aero-Engines, Ltd.	Cover iv
Brooklands Aviation, Ltd.	22, 25
Central Office of Information (Royal Navy)	Cover iii
Coley and Son (Hounslow), Ltd., R. J.	21
Cook Co., Frank R.	21
Cross Manufacturing Co. (1938), Ltd.	20, 22
Derby Aviation, Ltd.	20
Dzus Fasteners, Europe, Ltd.	8
Fairey Aviation Co., Ltd., The	Facing Edit. Page 506
Fishers	21
Flight Refuelling, Ltd.	17
Folland Aircraft, Ltd.	25
Garrett Corporation, The	9
General Electric Co., Ltd., The	7
Heinemann, Ltd., Wm.	6
Helliwells, Ltd.	6
Hobson, Ltd., H. M.	5
Iliffe and Sons, Ltd.	8
K.L.M. Royal Dutch Airlines	24
London School of Air Navigation	22
Marshall's Flying School, Ltd.	22, 26
Microcell, Ltd.	22, 25
Murad Developments, Ltd.	21
N.A.R. Agencies, Ltd.	20
Osterman's Aero	22
Power Jacks, Ltd.	8
Redwing, Ltd.	6
Robinson and Co. (Gillingham), Ltd., L.	4
Roe and Co., Ltd., A. V.	10, 23
Rozalex, Ltd.	20
Samlesbury Engineering, Ltd.	21
Scottish Aviation, Ltd.	25
Shell-Mex and B.P., Ltd.	Facing Edit. Page 507
Sperry Gyroscope Co., Ltd.	12
Suplex Lamps, Ltd.	21
Teddington Aircraft Controls, Ltd.	7
Venner Accumulators, Ltd.	19
Vickers-Armstrongs (Aircraft), Ltd.	18, 19
United Aircraft Export Corpn.	2, 3
Universal Flying Services, Ltd.	22
Wilson and Sons (London), Ltd., W.	4

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The Bristol Orion is an advanced concept, opening up new possibilities of versatile, low-operating-cost transport.

When the Bristol designers created the Orion, they successfully met these three demands—

1. Sea-level take-off power at any airfield in the world.
2. Specific consumption superior to the leanest existing engines.
3. The highest possible power-to-weight ratio in cruising flight.

FACTS ON THE NEW ORION

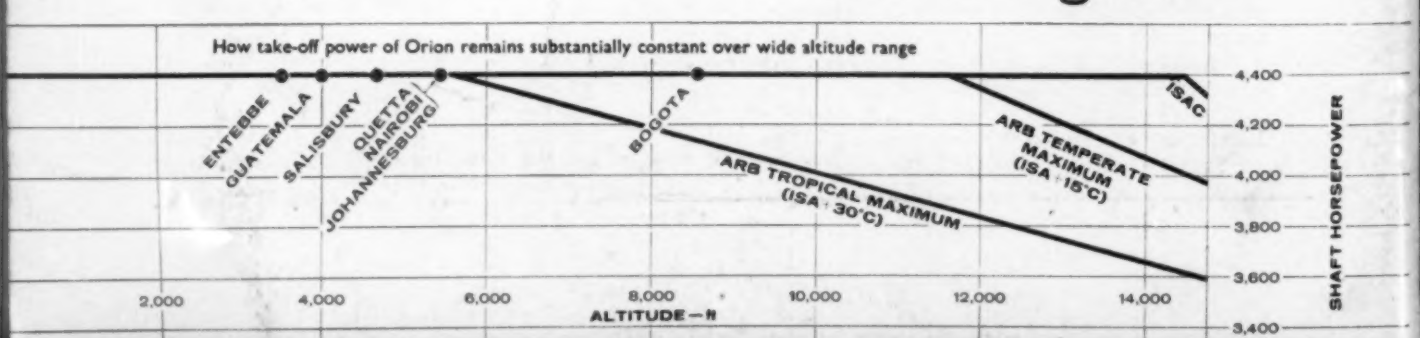
A two-spool constant-power turboprop. Take-off rating, 5,150 ehp.

Orion's twin compressors. Work split between low- and high-pressure stages is arranged to allow both stages to run near maximum adiabatic efficiency. The twin-spool layout also leads to unrivalled flexibility of operation.

Advantages of "gating". Orion is an 8,000 horsepower engine deliberately throttled at sea-level. At 30,000 feet and maximum cruising power it delivers 3,960 ehp. By restricting output to 5,000 ehp from sea-level up to 15,000 ft, propeller and reduction gear can be lightened—giving marked reduction in specific weight.

Yet for take-off at high temperatures or elevations the Orion can be given its head by simply opening the throttle.

Phenomenal economy. Specific fuel consumption of the Orion is well under 0.40 lb/ehp/hr. This phenomenal economy makes it possible to achieve long-range, ultra-low-cost transport of large payloads.

Orion-powered airliners will be able to operate in the region of 550 mph—thus achieving very high block-speeds at a lower operating cost than ever before.

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